ILLUMINATING ENGINEERING

JUNE, 1949

Trends Indicated at Lighting Exposition
Committee Report on Woolen Textile Mills
Merit Award Winners — I.L.E.
Louver and Louverall Systems
Remodeling Home Lighting
Lighting an Auditorium
Street Lighting Lamps

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

THE F. W. WAKEFIELD BRASS COMPANY

extends its congratulations to the following winners in the

Merit Award Competition

at the 3rd Annual International Lighting Exposition, Mar. 29—April 1, 1949, Hotel Stevens, Chicago

For Distinguished and Meritorious Use of Wakefield Lighting

WINNER	INSTALLATION	EQUIPMENT
Gold Seal Award (Entry No. 269): H. W. Horn Dept. of Electrical Engineering University of Illinois, Urbana, Ill. C. E. Oswald Graham, Anderson, Probst & White Chicago, Illinois	Electrical Engineering Machinery Laboratory University of Illinois	The Wakefield STAR
Merit Award with Distinction (Entry No. 16): James F. Finn The Detroit Edison Company Herbert A. Pettit Chief Electr., General Motors Bldg. Detroit, Mich.	Teletype Wire Room General Motors Building Detroit, Michigan	The Wakefield STAR
Merit Award (Entry No. 62): Hal Lang Monongahela Power Company Elkins, W. Virginia	General Store P. C. Curry Marlinton, W. Virginia	The Wakefield GRENADIER "Spot"
Merit Award (Entry No. 114): F. W. Fowler Buffalo Niagara Electric Corp. E. S. Burrows Electrical Consultant Buffalo, New York	Bookkeeping Office Kleinhans Men's Store Buffalo, New York	The Wakefield STAR
Merit Award (Entry No. 148): F. W. Fowler Buffalo Niagara Electric Corp. E. S. Burrows Electrical Consultant Buffalo, New York	Tailor Shop Kleinhans Men's Store Buffalo, New York	The Wakefield GRENADIER and COMMODORE

WINNER	INSTALLATION	EQUIPMENT
Merit Award (Entry No. 235): John T. Murphy Duquesne Light Company Pittsburgh, Pennsylvania	Classroom Vanport School District Vanport, Pennsylvania	The Wakefield GRENADIER
Merit Award (Entry No. 311): William H. Simms Union Electric Co. of Missouri St. Louis, Missouri	Office Ralston Purina Co., Inc. St. Louis, Missouri	The Wakefield GRENADIER
Merit Award (Entry No. 369): J. A. Lang Scott Whitnah, Lang & Asso., Inc. Minneapolis, Minnesota	Classroom Parish of the Visitation School Minneapolis, Minn.	The Wakefield GRENADIER
Merit Award (Entry No. 378): Joe L. Wilson and Walter M. Schulen Omaha Public Power District Omaha, Nebraska	Office C. A. Swanson & Sons Omaha, Nebraska	The Wakefield GRENADIER
Merit Award (Entry No. 379): W. J. Turner Omaha Public Power District Omaha, Nebraska	Office Western Newspaper Union Omaha, Nebraska	The Wakefield GRENADIER
Merit Award (Entry No. 388): Ben Cavin Omaha Public Power District Omaha, Nebraska	Office Guarantee Mutual Life Co. Omaha, Nebraska	The Wakefield GRENADIER
Merit Award (Entry No. 410): Warren W. Wens Pacific Gas & Electric Co. San Francisco, California	Club Room Musicians Union San Francisco, Calif.	The Wakefield STAR

THE F. W. *Wakefield* BRASS CO.

VERMILION, OHIO

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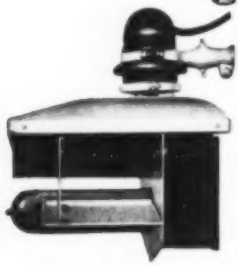

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ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

JUNE
1949

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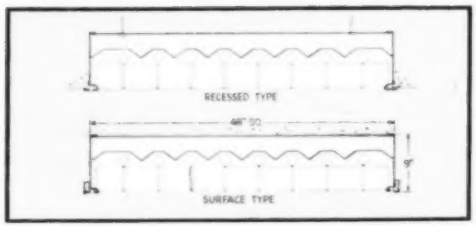

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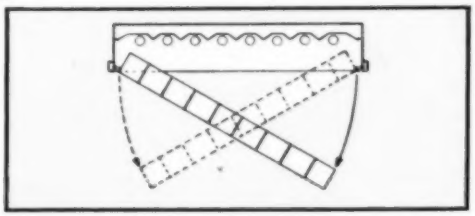

IT'S EASY TO SEE WHEN IT'S

DAY-BRITE *Lighting*

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Plan Your Summer to Include

French Lick

President L. E. Tayler

THIS YEAR the National Conference of the Society will convene at French Lick Springs, Indiana. French Lick is a small resort town, located in the South Central part of the state about 50 miles from Louisville. This section of the country is significant in that it marks the geographical center of concentration of our membership. This means that a record attendance should be established, a point to be considered in making reservations.

Located between highway 31 and 41, North and South, and just off East-West highway 50, French Lick is ideally located for those planning a motor trip to the Conference. From reports, many are arranging motoring parties with their Society friends now. The old slogan, "All Roads lead to French Lick" will be literally true. French Lick is also served by two railroads providing transportation nearly to the door.

This brief "travel agency" introduction is a sincere effort to urge your attendance. The Conference Committees, under the able leadership of R. F. Hartenstein and Robert Butts, and the Papers Committee, capably guided by Hoyt Steele, have merged the tireless efforts of their committee members to produce a most timely program of technical papers and discussions, by authors of proven authority. The Annual Conference is the only official assembly of all the membership for the dissemination and discussion of new facts, data and techniques in the rapidly evolving art and science of illumination. This year's technical program will offer 32 papers in addition to the parallel session of the Residence Lighting Forum. It is important to note that for the first time, the Conference offers a "Symposium on Color." The Papers represent a rather complete spread of study and investigation covering all phases of interest. It is an impressive program and should mark the dates of September 19 to September 23, as a week devoted to expanding our knowledge of the art.

Illuminating Engineering is becoming increasingly broad in its scope and is demanding a greater degree of skill in the application of its principles. The advantages of receiving first hand timely information and taking part in formal and informal discussions cannot be overemphasized.

Again this year, you are urged to attend the Lighting Service Forum. The Committee, under the Chairmanship of J. M. Stedman, will afford an unusual opportunity to those attending, and I urge you to earmark this session as a "must" on your Conference schedule. The Lighting Service Forum will present a practical demonstration of the methods and techniques used by the winners of the planned lighting awards, offered by the Edison Electric Institute and the Better Light-Better Sight Bureau this year. Here you will see demonstrated sound constructive adaptations of lighting design principles and educational methods applied to actual problems arising in the field and presented in an unusual and original manner. The Lighting Service Committee assures us that their program scheduled for Monday, September 19, will be a high point in this year's Technical Conference of the Society.

To the ladies, I want to extend a most cordial invitation. The whole tenor of our Conferences has been improved by your presence. Off the record, I would enlist your services as members ex-officio of the Conference Committee to develop persuasive, tactical methods that will win a "yes" answer to your question: "Are we going to the French Lick Conference this year?"

Mary Wren Held is the Chairman of the Ladies' Reception Committee and has prepared a full and interesting program for your entertainment and pleasure. When reservations are sent in, be sure they are made out for "*two*."

Remember the dates—the Lighting Service Forum on Monday, September 19; the Formal Opening of the Conference on Tuesday morning, September 20; Adjournment of the Conference on Friday afternoon, September 23.

Plan now to attend!

L. E. Tayler

President

Resumé and Impressions

Third International Lighting Exposition and Conference

By CARL W. ZERSEN

THE Industrial and Commercial Lighting Equipment Section of the National Electrical Manufacturers' Association conducted its Third International Lighting Exposition and Conference at the Stevens Hotel in Chicago from March 29 through April 1; it was well done and enthusiastically received by the thousands of people who attended.

The same sponsors also conducted the National Merit Award Competition; those present of the 217 winners in this competition received cash and certificate awards on the opening date of the Exposition.

The Exposition, the Conference and the Merit Award Competition were all designed and dedicated to raising the Standards of Illumination and thereby serving the public better; accomplishing this goal means an expanding market for Industrial and Commercial Lighting Equipment.

The Exposition

The large exhibit hall was open daily from noon to six o'clock and on Thursday until nine o'clock; over 7000 visitors inspected the displays; 1500 people were present on Thursday evening. The displays were cleverly and artistically arranged; the show was alive, it was a good show.

MR. ZERSEN is Managing Director of the Chicago Lighting Institute, Chicago, Illinois, and served as Chairman of the Board of Judges of the Merit Award Competition.

Quality

This was a footlambert rather than a footcandle show; comments on footcandles were the exception; most attendants in the luminaire exhibit spoke of low brightness as the criterion for their equipment on display; this shows progress; this trend is a credit to the Illuminating Engineering Society, whose leaders have talked and written "comfortable brightness" for years. The footlambert received more recognition than in any previous show. However, it is also true that all this "brightness consciousness" is expressed by most persons, including many in our own lighting industry, as something very vague; everyone speaks with confidence when referring to the footcandle, because all can define this term; this is not true of the footlambert; hence all of the generalities about "low brightness" luminaires.

The following ideas were incorporated by several of the fixture companies in their equipment to provide more comfortable brightness contrasts in the field of vision.

SPEAKERS' TABLE AT OPENING I.L.E. SESSION. — Left to right, B. J. Martin, Publisher and Editor of *Electrified Industry*, and Judge Merit Award Contest Committee; R. D. Bradley, Day-Brite Lighting, Inc., Chairman of Merit Award Committee; L. E. Taylor, Senior Engineer, Detroit Edison, President of Illuminating Engineering Society; G. T. Morrow, Sales Manager, Curtis Lighting, Inc., and Chairman of Exposition Operating Committee; B. W. Clark, Vice-President in Charge of Sales, Westinghouse Electric Corporation and President of NEMA; Carl Zersen, Manager, Chicago Lighting Institute and Chairman of Judges; William Foulks, Curtis Lighting, Inc., and Member of Merit Award Committee.

(a) Translucent plastic sides on industrial fixtures.
(b) Perforations in metal sides of industrial fixtures.
(c) Longitudinal louvers between lamps on industrial fixtures.
(d) Sectional louver ceilings.

Maintenance

Ease of maintenance and accessibility to auxiliary equipment also was featured more than at any previous show. This was as it should have been, because the keynote of the Exposition was "More Service to the Public." Ease of maintenance definitely falls in that classification. Fixture designers, electrical contractors, and consumers are all more maintenance conscious today. To achieve good and adequate maintenance is one of the biggest problems in lighting. A maintenance engineer, who had inspected every booth, remarked he was glad much thought was being given to the subject of maintenance, because keeping the fixtures clean and doing this work in a minimum amount of time without breakage to parts is a big problem. The superintendent of a large high school remarked that his school was going to wash fixtures only once a year and consequently suffer the loss in lighting efficiency rather than pay the high cost of keeping the equipment efficient and clean. The moral of this is that lighting systems must be designed for easy maintenance. One school in the Chicago area, which uses the open troffer and low-brightness lamps, provides a large vacuum cleaner with an extension hose for the use of the maintenance man in cleaning fixtures and lamps.

Following are ideas which the personnel in the fixture booths pointed out as soon as the subject of maintenance was mentioned:

(a) Easily removed louvers and lenses
(b) Louvers hinged on either side
(c) Reflectors easily removed by turn buttons and other holding devices
(d) Sturdy, stable sockets and holders
(e) Portable scaffolding and several special lowering devices
(f) Ease of assembly
(g) Ease of aligning fixtures with patented steel channels

Developments

Visitors to the exposition were impressed with the great variety of fixture designs and light sources; the lighting designer and application engineer has more tools at his disposal than ever before. The exposition proved that our industry is not static; it is vital and awake to the needs necessary to serve the public better.

Following are some developments which caused many comments. These are not new to the men within our industry; they are included here because there seems to be an increasing application of them:

(a) Greater acceptance of slimline lamps, operating at increasingly higher ma. The economics and lighting efficiency of operating these lamps at either 200 or 300 ma has been presented before and need not be repeated here.
(b) Increasing interest in the 96-inch 75-watt T12 lamps, operating at 424 ma. and even higher; this lamp at 425 ma. produces about the same lumen output as two 40-watt fluorescent lamps.
(c) More plastics for lighting application were shown than ever before. These included side panels in industrial fixtures; shields for residential lighting equipment and for use as louvered ceilings.
(d) An increasing number of different materials are being used in louver ceilings; these included aluminum, steel, plastic, photo-sensitized glass, and fibre board.
(e) Increasing use of incandescent downlights, individually and in combination with fluorescent.
(f) Increasing use of strip lighting, especially for valances, cornices, and cove lighting.
(g) There did not seem to be a definite niche for the circline lamp or circle arc; there are many places in industry (drill presses e.g.) and in stores (behind shields e.g.) where these lamps should find application in addition to their present use in portable table and floor lamps.
(h) Control of light was featured in several displays through new designs in lenses and by means of photo sensitive glass with "photographed in" louvers.
(i) Ballasts, lighter in weight, were an interesting new development.

Conference

Interesting conference programs had been arranged for each of the days of the exposition; a total of 2200 persons attended these programs; this included the 700 who were present on Tuesday morning, when the Cash and Certificate Awards were made to the winners in the National Merit Award Competition. Following is a list of the speakers, their affiliation and topics:

Tuesday Morning—Grand Ball Room

"Y B in Dark?"—G. T. Morrow, Curtis Lighting, Inc., Chairman, Exposition Operating Committee
"New Light on Planned Lighting"—Lee E. Tayler, Detroit Edison Co., President, Illuminating Engineering Society
"One Interest; One Goal"—B. W. Clark, Westinghouse Electric Corp., President, NEMA.
Presentation, Merit Awards—R. D. Bradley, Day-Brite Lighting, Inc., Chairman, Contest Committee

Wednesday Morning

"The Wholesalers' Part in Lighting Sales"—D. M. Sals-

(*Continued on page* 339)

Merit Award Winners . . . Third I.L.E. Contest

There were five separate competitions in this contest, one for each of the following groups:

1. Electrical Contractors
2. Utility Lighting and Power Representatives
3. Architects and Consulting Engineers
4. Wholesalers, Lighting Specialists and Salesmen
5. Owners and Users of Industrial and Commercial Lighting.

Three hundred and seven persons from among these five groups submitted 261 entries; some of these entries were submitted jointly; these persons came from 32 states of the Union, from Washington, D. C., and from Canada. From these 261 entries the five judges selected 14 Gold Seal Winners, 10 Merit Award with Distinction Winners, and 193 Merit Award Winners.

This shows that 217 entries out of a field of 261 received recognition in one form or another. Forty-four entries were rejected, because they either did not follow the rules of the competition or were not of Award caliber.

The presentation of the cash and certificate awards was made in the Ball Room of the Stevens Hotel on Tuesday morning, March 29, before an audience of 700 persons.

Gold Seal Winners

Twenty-three persons participated in the fourteen Gold Seal Entry winners. Every one received a framed Gold Seal Certificate plus a cash award. Individual winners received a check for $100.00; in the case of joint entries, the cash award was shared.

Geographically, the Gold Seal Entries came from: Illinois, 3; New Jersey, 3; Minnesota, 2; Ohio, 2; Alabama, 1; New York, 1; Pennsylvania, 1; Virginia, 1.

These fourteen entries included lighting installations in: five banks; four industrial plants; two schools; two stores; and one office.

Merit Award with Distinction

So many notable and excellent lighting installations were entered that the five judges made the recommendation to the Merit Award Contest Committee to establish another Award Classification; this recommendation was accepted and called "Merit Award with Distinction"; ten entries were placed in this newly created award class.

Geographically, these ten entries came from: Illinois, 3; Michigan, 1; Minnesota, 1; New Jersey, 1; Ohio, 1; New York, 1; Massachusetts, 1; California, 1.

These included the following types of installations: two stores, two schools, one office, one church, one highway, one industrial, one stadium, one bank.

Merit Awards

One hundred ninety-three persons won Merit Awards; these also included many excellent lighting installations; it is due to lack of space that these entries are not being described as are the top 24 in this issue.

****Double star denotes winners of the Gold Seal Merit Award.**

***Single star denotes winners of the Merit Award with Distinction.**

Jewelry Store

****Entry 266—P. E. Keys, Duquesne Light Co., Pittsburgh, Pa.; H. Rosenberg, Architect, Pittsburgh, Pa.**

Equipment: Illumination is provided from 3 rows of continuous surface mounted 4-lamp 40 w luminaires with twin adjustable incandescent reflector lamps between each of the 4 ft. fluorescent fixtures; all wall cases are equipped with continuous single strip fluorescent lighting; decorative niches and coves at rear of store are brilliantly illuminated to help draw traffic to that area.

Average illumination value is 75 ft-c.

Customer Comments: Our planned lighting is our best means for creating and maintaining public relations; good public relations will result in more customers and more sales; good lighting enhances and emphasizes all of our other store improvements; it puts life, color and beauty into a store; it makes buying in our store a pleasant, comfortable and exciting adventure.

Floral Shop

****Entry 165—H. G. Johnson, Northern States Power Co., Minneapolis, Minn. J. Christianson Electric Co., Electrical Contractor, Minneapolis, Minn.**

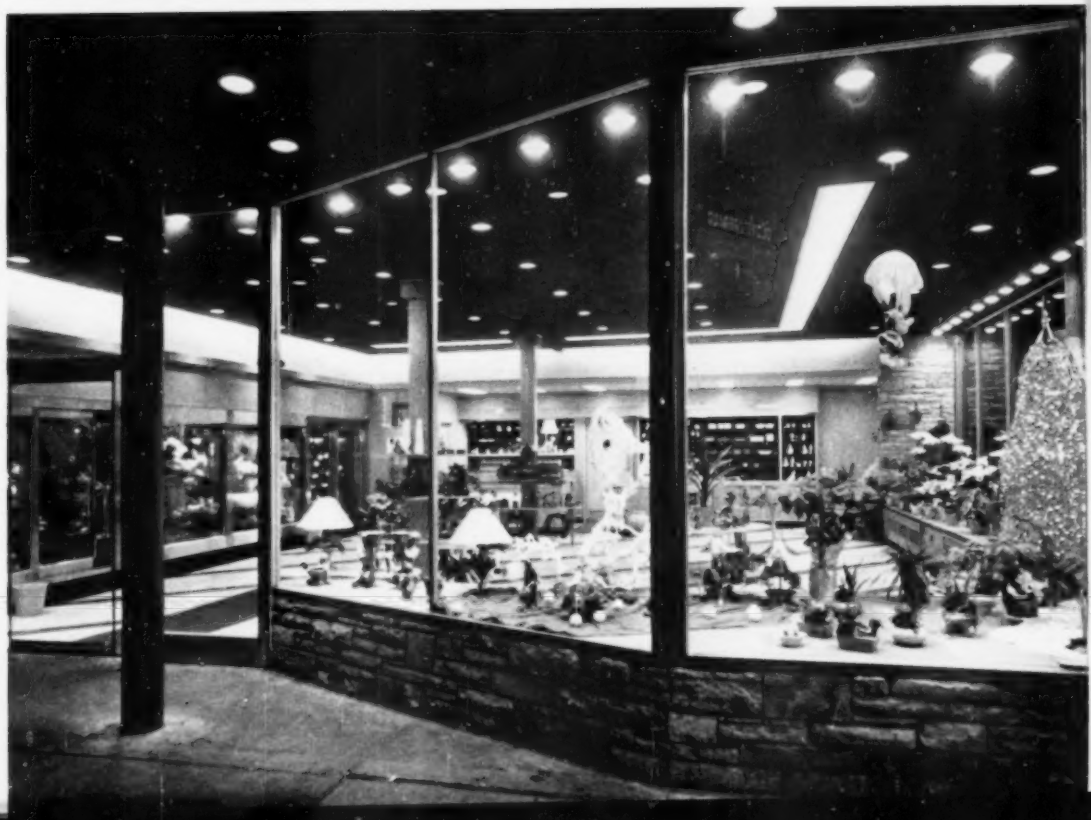
The store has a furred down ceiling 10$^{3}/_{4}$" high; this ceiling does not extend all the way to the left and rear wall, shown on the photograph. Forty watt fluorescent lamps on light strip, end to end, are located above the edge of the furred down ceiling; the cove formed by the outer wall and the area above the furred ceiling is 36" wide and 29$^{1}/_{4}$" high.

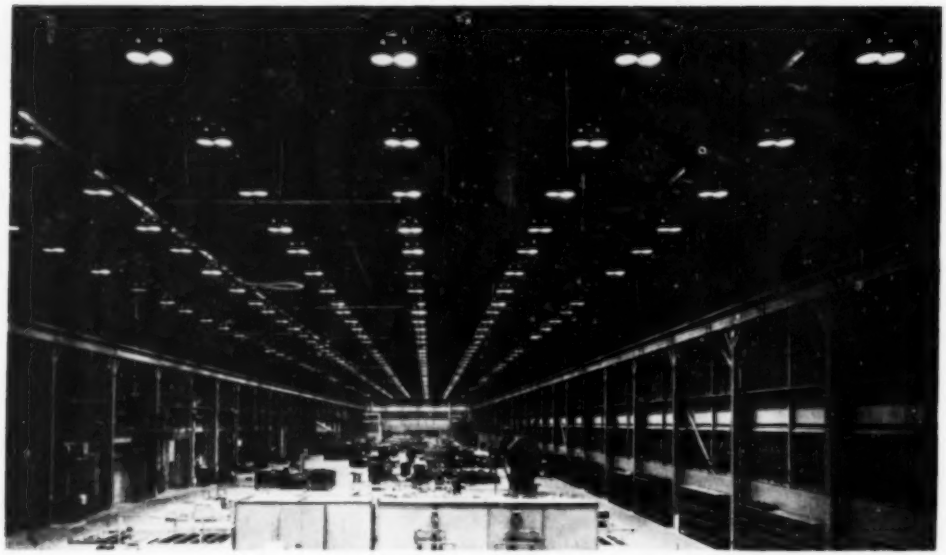
Numerous recessed downlights are on 5 ft. centers; each housing contains one 150 w K10 lamp with a clip-on louver flush with the ceiling.

Additional lighting is provided by recessed fluorescent troffers; those in the rear are 2 ft., 2 lamp troffers, end to end, on 4 ft. centers; the others, arranged in an L shape, are of the same type; all troffers have louvered hinges.

Average illumination level with all lights on—35 to 50 ft-c.

Recessed downlights in the show window are of the same type used in the store proper, on 2 ft centers.





Press Work and Steel Storage Plant

****Entry 176—R. S. Hoffman, Perfection Stove Co., Cleveland, Ohio; G. Chittendon, G. S. Rider Co., Architects, Cleveland, Ohio.**

Physical Area: Length 855 feet; width 110 feet; height 43 feet.
Fixture spacing throughout entire area 17 feet by 16 feet 10 inches.

Equipment: This area is lighted with a total of 313 twin-type alzak aluminum high bay fixtures, spaced in six parallel rows; the press section employs one 400-w mercury lamp and one 1000-w incandescent lamp per twin unit; the steel storage section with the same unit uses the same size mercury lamp with a 750-w incandescent lamp.

Illumination Values: press section, 45 ft-c; storage section, 36 ft-c.
Readings were taken at 8:30 p.m.

Average brightness of 1000-w incandescent lamp, 33,000 ft-L; of 400-w mercury vapor lamp 25,000 ft-L.

Customer Comments: Each twin fixture is individually controlled by switch at the lighting panel; fixtures are all maintained from the bridge of a traveling crane.

Private Office

****Entry 194—E. C. Hinck, Jr., Montclair, N. J.**

Equipment: Suspended ceiling is composed of wooden cells, 11¾" square; distance between ceiling and top of cells is 15"; distance from bottom cells to floor is 8' 6".
Fifteen parallel rows of slimline striplites on 12" centers provide the illumination; thirteen rows have two 96" and one 72" slimline end to end; one row has one 96" and one 42" slimline end to end. Striplites are mounted on the ceiling.

Illumination Value: 75 ft-c average.

Brightness Values: Inside of cell sides, 113-122 ft-L; on picture, 23 ft-L; on table top, 27 ft-L; corner curved wall, 19-25 ft-L.

Customer Comments: Find the new lighting system very comfortable and pleasing. "Visitors in my office marvel how the lighting can be so good and yet so inconspicuous; this system helps complete the modern effect which I desired to obtain."

Electrical Engineering Machinery Laboratory

****Entry 269—H. W. Horn, Dept. of Electrical Engineering, University of Illinois, Urbana, Ill.; C. E. Oswald, Assistant Electrical Engineer, Graham, Anderson, Probst & White, Architects, Chicago, Ill.**

Physical Area: Length, 157′; width, 83′; height, 13′ 6″.

Equipment: This entire area is illuminated with 79 translucent, plastic, indirect luminaires; all equipped with 96-inch, 4500° slimline lamps, operating at 300 ma and 120 volts. Forty-seven luminaires are 8 feet long and 32 are 16 feet long. Spacing between them is 8 feet. Total wattage, including auxiliaries, is 49.5 kw or 3.85 watts per sq. ft.

Reflection Factors: side walls—light green, rough concrete block, 55%; ceiling—white, matte acoustic tile, 85%; floor—mottled green, smooth asphalt tile, 17%. Illumination readings were taken 35 inches above the floor, which was the height of the movable instrument benches; average reading, 45.5 ft-c. Brightness values as recorded on the entry were all within the accepted range. A difficulty which the designers overcame was the presence of large ventilating ducts, the position of which had to be established to interfere least with the lighting system.

High School Classroom

****Entry 316—W. E. Turnbull, Public Service Electric & Gas Co., Plainfield, N. J.; N. Plainfield Board of Education.**

Physical Area: Classroom length 29 feet 9 inches; width 24 feet 6 inches; height 11 feet 10 inches.

Equipment: Four continuous rows, luminous indirect fixtures; five fixtures per row with two 40-watt lamps per fixture. Fixtures are mounted 9′ 10″ above the floor.

Color Scheme: Ceiling and upper walls are white; rest of wall, woodwork and cabinets is pastel green; furniture and desks were resanded and given a blond finish; maple floor was restored to its natural light appearance; chalkboard is green.

Illumination Levels: Chalkboard (vertical), 27 ft-c; sidewalls (vertical), 31 ft-c; desk tops, outside row, 47 ft-c; center row, 51 ft-c; inside row, 48 ft-c.

Brightness: Chalkboard, 42 ft-L; fixture bottom, 116 ft-L; ceiling above fixture, 97 ft-L; furniture top, 17 ft-L; floor 5.6 ft-L.

Customer Comments: Classroom is very restful and cheerful. Modernization of this room is the best investment we have made; we plan to relight other rooms similarly (*Principal*). There is increased interest in school work and better cooperation between teachers and students (*Teacher*). We take greater pride in keeping the room clean. I am less tired at the end of the day, due to less eye strain (*Student*).

Coach Yard Maintenance

****Entry 276—G. H. Seiter, Cincinnati Gas & Electric Co., Cincinnati, Ohio; R. E. Hause, Cincinnati Union Terminal, Cincinnati, Ohio.**

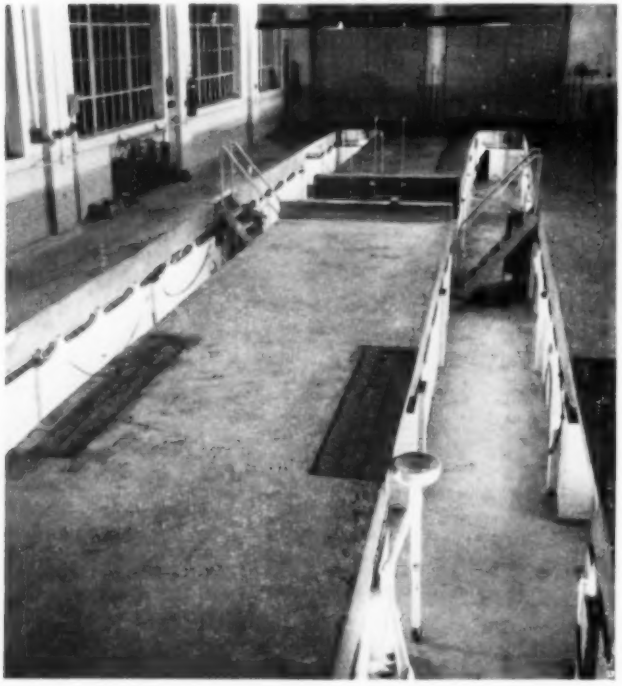
The problem is to provide both good general lighting in the coach yard and also sufficient light on the side of the coaches for cleaning purposes, because much of the work has to be done at night.

Equipment: A total of 104 street lighting luminaires illuminate 8300 feet of lineal track. These luminaires are on a spacing of 80 feet; the light center of the lamp is 24 feet above the ground. Fifty-two of the units employ the EHI 400-watt mercury vapor lamp and the remaining fifty-two use 750-watt incandescent lamps. The two light sources are installed alternately. The optical system of each luminaire confines the light to narrow areas and at high angles to provide high levels of vertical illumination.

Starting and restarting of the mercury vapor lamps, even in zero weather, was quicker than the time generally quoted in lamp data bulletins.

All units are cleaned every 90 days. Illumination values on the vertical side of the coaches varies from a minimum of .22 ft-c near the bottom center of the coach to a high of 4.9 ft-c at the top and closest to the light source.

Customer Comments: Plans are now underway to triple the installation to 312 units; these will then illuminate 25,000 lineal feet of track.



Maintenance Shop, Bus Terminal

****Entry 233 — W. H. Rorabough, Hudson Morgan Co., Inc., Lynchburg, Va.**

Illumination for pit area is obtained from lighting units, recessed on 4-foot centers on either side of the pit in a staggered arrangement; pits are 4 feet wide; each lighting unit has a 200-watt clear lamp in it.

Illumination level on the underside of buses is 24 ft-c.

Customer Comments: Since remodeling, the pit lighting has had its proportional share in a 33⅓% increase in efficiency of operation; we no longer need to use extension cords. We intend to use the same lighting layout when we relight other pit locations.

Bank Lobby and Office

****Entry 361 — B. E. Sanderson, Public Service Co. of Northern Illinois, Joliet, Ill.**

Ceiling over lobby area is 14 feet and in office area 9 feet high; a plastered cove, containing three parallel rows of 3500° fluorescent lamps extends along the entire area where the lobby and office area ceilings meet. The lobby or public area proper is illuminated with four suspended fixtures, each one containing one 300-watt silvered bowl lamp.

The office area employs recessed troffers, equipped with louvers, placed in parallel rows, end to end, and two 40-watt 4500° lamps per unit. Over the counter and cage area, the troffers are equipped with three 40-watt lamps per unit and "Alba" glass instead of louvers. Illumination level average in public area, 38 ft-c; in office area, 55 ft-c.

Reflection Factors: Ceiling, plaster, white, 80%; wall, plaster, green, 64%; walnut veneer, 16%; floor, rubber tile, brown, 10%; cream, 34%.

Customer Comments: Our new lighting creates the proper atmosphere of distinction; it also gives us the right amount where we need it. Our employees find it comfortable and pleasant to work under.

Dimensions: Room length 56 feet, width 41 feet.

Equipment: Eleven 4-foot plus four 2-foot troffers are in each row, running length of the room; troffers are on 4-foot spacing. Each troffer has four lamps, and a separately hinged louver for each two lamps per troffer.

Total wattage is 10.4 kw, including ballast losses, or 4.5 watts per sq. ft. Average illumination in service 81 ft-c. Brightness on ceiling between troffers, 42.51 ft-L.; brightness in center of floor area, 58 ft-L.

Customer Comments: Patrons of our bank, as well as our employees, regard this as a most acceptable type of installation.

Bank Lobby

****Entry 20—J. L. Phillips, Birmingham, Ala.**

Bank Lobby

****Entry 325—R. B. Thompson, General Electric Supply Corp., Buffalo, N. Y.**

The public lobby is 58 feet by 23 feet; this entire area has a suspended, translucent louver ceiling with cells 2" square; the distance from the floor to the louver ceiling is 11' 1". A total of 77 surface-mounted 96" slimline, 3500° lamps, operated at 300 ma, provide an average illumination value of 90 ft-c; each lamp is used in a symmetrical reflector of baked white synthetic enamel.

Total wattage in this area is 6930.

Reflection Factors of floor (asphalt tile, warm gray), 34%.

Brightness of cellular ceiling at 30° angle, 220 ft-L; of floor, 30 ft-L.

Bank Lobby and Office

****Entry 31—J. O. Kvalsten, Kvalsten Electric Co., Inc., Minneapolis, Minn.; D. Greene, Larsen & McLaren, architects; B. R. Bunn, Westinghouse Electrical Supply Co., Minneapolis, Minn.**

Public area is partially lighted from a large diameter cove; distance from tip of cove to ceiling immediately above is 15¾"; distance from tip of cove to area immediately underneath cove is 6½"; distance from rear wall to inside front of cove is 18".

Equipment: Cove is equipped with three concentric continuous rows of fluorescent lighting. Downlights are recessed around perimeter of cove; these are 150-watt PAR38 lamps, equipped with concentric louvers, flush with the underside of the cove. Downlights around each of the two columns are 100-watt inside frost lamps in a housing, equipped with 3¼" diameter lenses, also flush with the ceiling. Downlights within the ceiling of the cove contain two 300-watt PS35 lamps; these rectangular boxes are equipped with flat prismatic lenses, also flush with the ceiling; their purpose is to provide adequate illumination on the reception and check writing desk. Office area shown employs recessed troffers and prismatic lenses with two lamps per troffer.

Illumination level: center of public area, 25 ft-c; reception and check writing desk, 38 ft-c; office area, 40 ft-c.

Brightness values: inside cove, 280 ft-L; troffer bottom, 190 ft-L; floor, 4.5 ft-L; column (eye level), 7 ft-L.

Customer Comments: Our tellers like the lighting, because they do not have shadows to interfere with their work; we appreciate the maximum lighting levels at a minimum cost; our lighting system has made our banking offices a show place in the business community.

Banking Office

★★Entry 423—F. W. Martin, Graybar Electric Co., Chicago, Ill.

Two entire floors were relighted in this bank; both floors employed the same lighting system. A total of 7000 5-foot troffers were used.

Equipment: Continuous rows of aluminum low brightness troffers on 3-foot centers, each troffer lamped with one 40-watt T17, 60-inch low brightness lamp; distance from troffer edge to floor, 89 inches. Crosswise the reflector has a shielding angle of 40 degrees.

Reflection factor, ceiling (metal tile), 80%; brightness, 5-8 ft-L; reflection factor, carpet (beige pattern), 25%; brightness, 8-10 ft-L; illumination throughout working area, 65-70 ft-c; watts per sq. ft. are 3.6.

Present mahogany desks to be replaced with desks of light color.

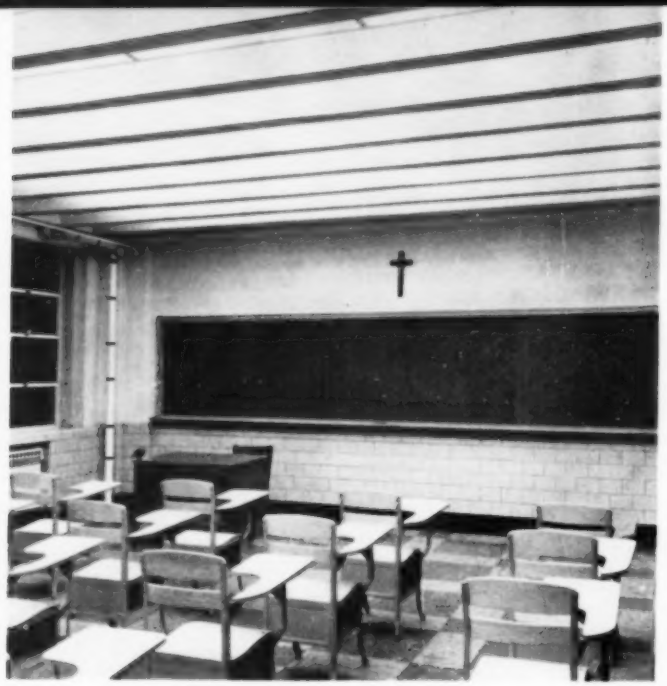
Customer Comments: The lighting system has a profound effect upon client relations, employee relations, and employee efficiency; it has proved to be a sound investment. We have controlled brightness throughout the entire field of vision.

Electrician's Shop

★★Entry 299—E. M. Fahey and J. A. Heffernan, Public Service Electric & Gas Co., Newark, N. J.

Equipment: Suspension type, semi-direct fluorescent units, mounted in rows, end to end. Reflectors are of two- and three-lamp types, mounted 12 feet above the floor; ceiling is comfortably lighted because of upward component of light. Illumination level average is 55 ft-c. Brightness: fixture sides, 6.3 ft-L; fixture insides, 280 ft-L; wall above doors, 24 ft-L; louver part of wall, 4 ft-L; table top, 7 ft-L; floor, 2.8-3.6 ft-L.

Customer Comments: Employee reaction to lighting system is excellent; electricians no longer needs local lights nor extension cords; this saves time and improves quality of the work; men are more relaxed; management is happy to have had this lighting system installed.



High School Classroom

★Entry 111—H. M. Sharp, Snyder, N. Y.

The structure forms part of the luminaire; concrete beams are 6″ wide; coffers between beams are 12″ deep and 20″ wide, running continuous from window to corridor wall.

Placed on the ceiling of 12 of the structural coffers is a luminaire, utilizing two 96″, 3500°, 200 ma slimline lamps per coffer. Underneath the lamps in each coffer are diffusing panels of "Alba" glass, 10″ wide; these panels are held in hinged frames; there are no sides to the luminaire; the beams act as shielding louvers.

Watts per sq. ft. are 2.5; utilization coefficient of the luminaire is 50% plus.

Reflection Factors: green chalkboard, 14%; floor, 16-24%; walls, 50-60%; ceiling, 85%. Chair desk tops, 63%. Illumination value in service 45 ft-c plus.

Customer Comments: Lighting installation is simple and easy to maintain; brightness values are all low; the entire system is in harmony with the structure.

Library Reading Room

★Entry 173—W. W. Thompson, Thompson Engineering Co., Milton, Mass.

General indirect lighting is provided by ceiling fixtures, each one equipped with one 750-watt silver bowl lamp spaced in the center of four concentric louvers.

Additional indirect lighting comes from coves, 3″ deep and 7″ wide; the distance from the bottom front of the cove to the ceiling immediately above is 45″; lighting equipment within the cove consists of two rows of 3500° cold cathode tubing operating at 120 ma.

Direct lighting in the center area of the room comes through louver sections, 25″ square, with cells 3⅛″ wide and 2⅝″ deep. Fluorescent lamps on 12″ centers run the entire length above the louver sections. Distance between lamps and louver section is 6″.

Illumination values: center of room, 49 ft-c; nearest to wall, 21 ft-c.

Banking Office

★Entry 445—K. W. Moore, Chicago Title & Trust Company, Chicago, Ill.

Physical Data: Area is 110′ x 120′; ceiling height varies from 8′ 6″ to 9′ 6″.

Equipment: All lighting equipment consists of alzak processed aluminum troffers, equipped with louvers, which hinge from either side and are removable; each troffer contains two 40-watt 3500° lamps; troffers are on 8-ft. spacing, with lengths of either 8 or 16 ft.

Reflection Factors: Ceiling, white acoustitile, 75%; floor, gray broadloom rugs; sidewalls, dark red, buff and gray, wood, 5%; plaster, 50%.

Customer Comments: After occupying our quarters for several months, we feel that the results of our careful studies on lighting, air conditioning, sound and color have justified our selection. This is borne out by comments of our employees, compliments of our customers and frequent inquiries by others who are planning similar installations.

Church Lighting

★Entry 168 — H. W. Johnson and H. E. Petersen, Commonwealth Edison Co., Chicago, Ill.

Problem was to provide 15 ft-c of artificial lighting in the church pews; also to illuminate ceiling murals and provide favorable lighting contrasts within church.
Equipment: Twenty-seven uniformly spaced elliptical reflector downlights, each equipped with a 750-watt lamp, recessed in the ceiling, provide direct lighting within the church.
Twenty spun aluminum reflectors, with a 150-watt PAR38 projector spot lamp in each, illuminate the ceiling; two of these units are housed in a well above each of the ten windows.
Four additional recessed downlights project a high intensity in the sanctuary and also illuminate the inscription on the arch.
Recessed ceiling units are maintained from a catwalk above the ceiling; all others can be serviced with a 6-foot ladder.

Eight-Lane Dual Highway

★Entry 298—B. J. Jensen, Public Service Electric & Gas Co., Newark, N. J.; J. L. Hays, N. J. State Highway Dept.

Data: Width of highway 152 feet; length of highway lighted 3⅛ miles; three rows of lighting standards—one double arm standard along the center and one row on each side of highway; standards on side of highway are opposite each other double arm standard in staggered spacing between outside rows.

Length of arm supporting refractor units; outside rows—15 feet; center—12 feet; height of all lamp centers—25 feet above highway; spacing between lighting standards 175 feet.

All lamps are incandescent—6000 lumen output. Average illumination level .526 ft-c.

Teletype Wire Room

★Entry 16—J. F. Finn, Detroit Edison Co., Detroit, Mich.; Bert Pettit, Chief Electrician, General Motors Bldg., Detroit, Mich.

Problem is to read communication tape through a glass shield; to reduce reflected glare is of the utmost importance.

Equipment: Luminaires are of the molded, translucent indirect type; there are three parallel rows with five luminaires in each row; each luminaire contains four 96″ 3500° slimline lamps, operating at 200 ma. Luminaires are on a spacing of 8′ 6″ and 9 feet above the floor; ceiling is 12 feet high.

Color Scheme: Side walls are light green; office equipment is medium green; ceiling is flat white.

Average illumination level is 39 ft-c.

Brightness: Ceiling, between fixtures, 37 ft-L, above fixtures, 70 ft-L; fixture sides, 110 ft-L.

Comments: Our employees are greatly pleased with our new lighting system; we have neither glare nor eyestrain nor shadow.

Auto Showroom

★Entry 330 — H. E. Carney, Toledo Edison Co., Toledo, O.; Carl Hoke, Architect, Toledo, O.

Recessed troffer near top window edge is equipped with two rows of continuous strip lighting, employing 40-watt 3500° lamps; also in the ceiling near the window are two 150-watt R40 spot lamps. Coves provide the lighting for the display room proper.

Cove No. 1, 4 feet from the window, employs 26 85-watt T17 lamps. Cove No. 2, 5′ 2″ from the lip of cove number one, employs 22 85-watt T17 lamps. Cove No. 3, same spacing, uses 18 85-watt T17 lamps. Cove No. 4, same spacing, uses 14 85-watt T17 lamps.

In addition, each cove has several "fill in" lamps, either 40-watt, 30-watt or 20-watt lamps, depending on the space requirements. The fixture in front of the draped curtain is 68″ in diameter. In this fixture are three rows of cold cathode tubing, one neon red, one gold and one 4500°; a switch controls each color. In the center is a 300-watt R40 louvered spot lamp. Average illumination value in display room 50-60 ft-c.

Printing Press Room

★Entry 413 — F. D. Wyatt & W. H. Miller, Chicago Park District, Chicago, Ill.

This is an L-shaped room; all fixtures have translucent plastic sides and plastic louver bottoms; all of the 38 fixtures are equipped with two 40-watt, 4500° lamps mounted 11′ 1″ above the floor.

Average illumination level is 40 ft-c.

Home Furnishing Store
★Entry 214

Public Stadium
★Entry 437

Third I.L.E. . . .

(Continued from page 325)

bury, Westinghouse Electric Supply Co., Vice-President, National Electrical Manufacturers' Association

"Where Do Business and Lighting Go from Here?"—Eric Johnston, President, Motion Picture Association of America

"What the Lighting of the Future Will Mean to You"—Alston Rodgers, Lamp Dept., General Electric Co.

Thursday Morning

"The Power Companies' Part in Lighting Sales"—Ralph P. Wagner, New York Power & Light Corp., Chairman, Better Light, Better Sight Bureau

"How Atomic Power Will Affect the Future of Lighting"—Ward F. Davidson, Consolidated Edison Co.

"Glass Comes of Age"—H. G. Vogt, Corning Glass Works

Friday Morning

"The Contractors' Part in Lighting Sales"—Robert W. McChesney, President, NEMA.

"A Little Light on Color"—Julian Ellsworth Garnsey, Colorist

"Plastics, the New Look in Lighting"—F. W. Tetzlaf, Rohm & Haas Co.

Home Furnishing Store

★Entry 214—L. Riegert, Northern States Power Co.; McEnary & Kraft, Architects, Minneapolis, Minn.

Equipment: General indirect lighting is provided by 2 parallel rows, with 5 60" coffers per row; each coffer is wired for a 1500-w silver bowl lamp; maximum depth of each coffer is 17¼". Inside surface is a matte plaster finish.

General direct lighting comes from 5 parallel rows of recessed louvered downlights, each equipped with a 150-w PAR38 lamp.

Specific Area Lighting: Fabric section is lighted with 2 parallel rows of 1" diameter cold cathode tubing plus 100-w incandescent lamps at regular intervals concealed behind a valance. Rear luminous wall is illuminated with 1-ft. diameter, 36" length cold cathode tubing. Adjustable surface mounted ceiling units, equipped with 150-w PAR38 spotlights in louver covered housings, highlight the merchandise along the wall area. Show window lights are adjustable units equipped with 150-w PAR38 lamps.

Customer Comments: The soft indirect lighting from our coffer units is augmented by the recessed downlights; our lighting is flexible, so our merchandising displays need not be tied down to any one location. Our lighting system is the greatest asset in our new store design; the most important point is that our lighting sells merchandise.

Public Stadium

★Entry 437—R. E. Bennett, Bennett & Bennett, Pasadena, Calif.

Each of the 6 towers has 72 projectors on it or a total of 432; each projector has in it an alzak reflector, a 1500-w, 115-volt G48 lamp and is enclosed with a clear plain lens.

Customer Comments: Lighting the stadium for night use has doubled the events.

Gallery of Merit Awards

The 217 winning entries in the Merit Award Competition were on display in the Exhibition Hall; this section proved to be one of the biggest magnets at the show; a description of the top 24 entries plus statistics on this competition can be found in another section of this issue.

Observations—Merit Award Winners

For purposes of analyzing the top 24 entries as to type of equipment and light source used, they were classified as shown here:

Application	*No. of Installations*
Industrial	5
School and Office	9
Store and Sales Areas	4
Bank Lobby, Library, Church	6
Stadium and Highway	2

This makes a total of 26 lighting installations; the difference between this and the figure of 24 entries referred to above is accounted for by the fact that in two instances the lobby and office area in two banks were so closely allied they were treated as one area in the entry; in this analysis they have been treated separately as a lobby and an office.

Industrial

	Light Sources	*Equipment Type*
1.	Fluorescent—40-w preheat	Semi-Direct
2.	Incandescent—200-w	Wall recessed pit
3.	Mercury—400-w; incandescent 100 and 750-w	Twin high bay
4.	Mercury—400-w; incandescent—750-w.	Street light standards
5.	Fluorescent—40-watt preheat	Luminous side panel—direct

School and Office

1.	Fluorescent—40-w preheat	Luminous plastic—indirect
2.	Fluorescent—40-w preheat	Recessed troffer—louver and glass panel bottom
3.	Fluorescent—40-w preheat	Recessed troffer—prismatic lenses
4.	Fluorescent—56" slimline	Louvered wooden cell ceiling
5.	Fluorescent—96" slimline	Luminous plastic indirect
6.	Fluorescent—low brightness 40-w lamp	Recessed troffer
7.	Fluorescent—96" slimline	Luminous plastic—indirect
8.	Fluorescent—96" slimline	Direct (coffer); diffusing glass panel
9.	Fluorescent—40-w preheat	Recessed troffer—louver bottom

Store and Sales Area

	Light Sources	*Equipment Type*
1.	Fluorescent—40 w preheat	Reverse cove
	Incandescent—150 w R40	Downlights—louver bottom
	Fluorescent—40 w preheat	Recessed louvered troffer
2.	Fluorescent—40 w preheat	Surface mounted—louver bottom
	Incandescent—150 w PAR38	In combination with fluorescent
3.	Incandescent—1500 w silver bowl	Fixture suspended in 60" D. coffer
	Incandescent—150 w PAR38	Recessed downlights
	Fluorescent—cold cathode	Valance lighting
4.	Fluorescent—40 w preheat	Recessed troffer
	Fluorescent—85 w	Coves
	Fluorescent—cold cathode	Special circular fixture

Bank Lobby—Library—Church

	Light Sources	*Equipment Type*
1.	Fluorescent—40 w preheat	Cove
	Incandescent—300 w silver bowl.	Indirect
2.	Fluorescent—40 w preheat	Cove
	Incandescent—150 w PAR; 100 w; 300 w	Recessed louvered and lens downlight
3.	Fluorescent—30 w preheat	Recessed troffer
4.	Fluorescent—96" slimline	Luminous louver ceiling
5.	Incandescent—750 w; 150 w PAR38	Concealed indirect
6.	Incandescent—750 w silver bowl	Indirect fixture
	Fluorescent—cold cathode	Cove
	Fluorescent—72" slimline	Sectional louver ceiling

Stadium—Highway

	Light Sources	*Equipment Type*
1.	Incandescent—6000-lumen lamps	Single and two-arm standards
2.	Incandescent—1500 w lamps	Floodlight projectors

Average Illumination Levels

The fluorescent lamp made possible the higher levels of illumination which the user of light enjoys today; the average for the indoor installations entered in this contest was 49 footcandles.

Industrial	40 ft-c	Office	52 ft-c
School	45 "	Store	53 "
Bank Lobbies and Library	56 ft-c		

Summary

Not enough installations are involved in this brief summarization of the top 24 entries to point out trends; it does show that the incandescent lamp was much in evidence except in the school and office entries; luminous plastic indirect fixtures and the recessed troffer, equipped with either lenses, diffusing glass panels or louvers were used to a considerable extent; illumination levels are at an all-time high; the fixture industry is "brightness-conscious"; much thought is being given to ease of removing auxiliary equipment, reflectors, and lamps for maintenance and cleaning.

The Exposition, Conference, and Merit Award Competition proved conclusively that our industry is alive, alert and on the move; this is a healthy condition; we look forward now to International Lighting Exposition and Conference Number Four.

OFFICIALS AT OPENING CEREMONIES OF THIRD I.L.E.—Left to right, W. J. Donald, Managing Director, NEMA; E. C. Huerkamp, Exposition Operating Committee; R. W. Staud, Chairman, Publicity and Attendance Promotion Committee; L. E. Tayler, President, Illuminating Engineering Society; B. W. Clark, President of NEMA—in act of cutting the ribbon; G. T. Morrow, Chairman, Exposition Operating Committee.

Louver and Louverall Systems

Design and Illumination Characteristics—Part II

By WENTWORTH M. POTTER
R. L. OETTING

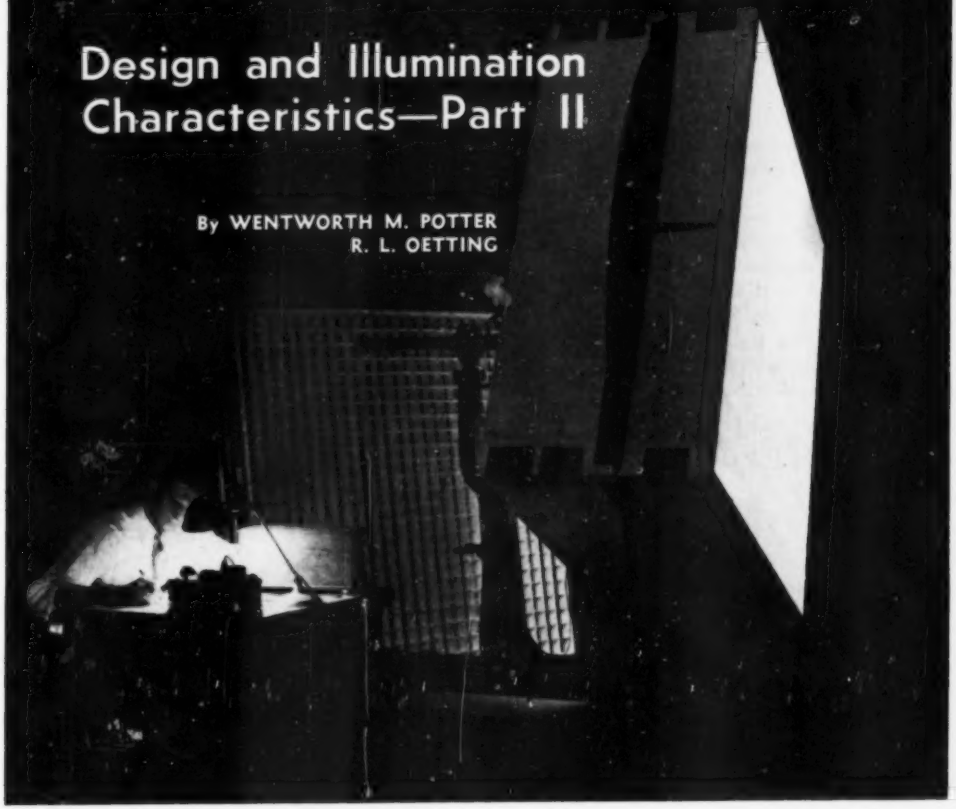


Figure 10. View of laboratory test equipment: the variable depth cavity, the photometer head, several typical louvers, and certain electrical and photometric instruments.

The appraisal of louver systems and summary of their characteristics in Part I is supplemented in Part II by the more detailed evaluation of the effect of variables on efficiency, utilization and average brightness, as needed by the architect, equipment designer and application engineer. The effect of each variable is presented independently with some indication of interrelation with the many other factors.

WITH such wide range in size and design of louver systems, it would be impracticable to make a comprehensive evaluation of the numerous variables by measurement of actual installations, with conditions controlled and correlated. Hence, laboratory measurements on an element of reasonable size were necessary. The general applicability of data obtained with a test element of limited lateral dimensions was established (see Fig. 25) by comparing tests on cavities of (1) fixed depth and variable size, and (2) variable depth and fixed size. These confirmed that proportionality of cavity and element dimensions, rather than actual dimensions, is the dominant factor.

The photometric equipment and procedures employed were not unlike those that are well established for conventional luminaires. The principal test unit consisted of a six-foot-square wooden box of variable depth, fixed to a photometer head which provided rotation in both horizontal and vertical planes. Louver sections were inserted into the open face of this test cavity. The mount was adjustable horizontally so that the vertical

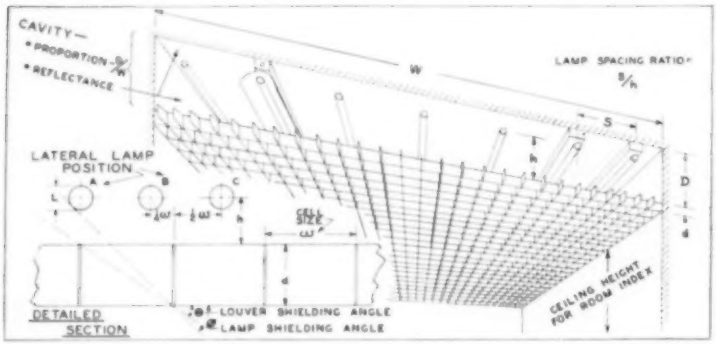
Part II of a paper presented at the National Technical Conference of the Illuminating Engineering Society, September 24, 1948, Boston, Mass. Part I, ILLUMINATING ENGINEERING, Vol. XLIV, No. 1, p. 16 (January, 1949). MESSRS. POTTER and OETTING are with the Engineering Division, Lamp Department, General Electric Company, Nela Park, Cleveland, Ohio.

axis of rotation was always in the plane of the outer edges of the louver blades. Photometric measurements were made at 40 feet from this axis with color-corrected, barrier-layer type, photoelectric cells. A precision laboratory galvanometer was used. Candlepower distribution, output efficiency, and average brightness were thus obtained.

Only fluorescent lamps were employed. Performance with filament lamps should be roughly similar. More frequently, filament lamps will be employed for controlled beam lighting. The use of a single lamp, centrally located in the cavity, permitted maximum photometric accuracy. Further tests evaluated the obstructing effect of additional lamps.

Since the lateral position of the lamp with respect to parallel louver blades sometimes introduces significant effects, most results are weighted for random lamp position.* Further simplification has been realized from the fact that for random position the distance (h) of lamps above the grid has no effect when (1) the cavity ratio is constant, and (2) reflectances are of the order of 75 per cent. Names and symbols employed in presenting test results are defined in Table II and illustrated in Fig. 11.

Figure 11. Symbols and nomenclature. Definitions — see Table II.



Effect of Louver Grid Variables

Effect of Louver Shielding Angle on Efficiency and Candlepower Distribution. — Relationships based upon louver shielding angle are so fundamental that they will form the basis for most louver

*Unless otherwise specified, this condition applies for all presentations, comparisons and analyses.

Table II.—Nomenclature, Symbols and Definitions

For convenience, specific names and symbols have been adopted for the basic features and concepts of louver and louverall systems:

Louver Grid—The complete assembly of individual louvers or blades which form the louver cells.

Cell Size (w)—Lateral dimensions of the individual cells formed by the louver blades.

Cell Depth (d)—Width of louver blades or depth of cell.

Louver Shielding Angle (θ)—The angle between the plane of the louver grid and the plane at which the louver conceals all objects above; in square or rectangular cell louvers, the planes are generally so chosen that their intersection is parallel with the louver blades.

Blade Reflectance (r)—The light reflectance of blade finishes, obtained with a Baumgartner Light-Cell Reflectometer.

Blade Transmittance (t) — The light transmittance of blades, obtained with a Baumgartner Light-Cell Reflectometer.

Lamp Shielding Angle (ϕ)—The angle between the plane of the louver grid and the plane most nearly horizontal which is tangent to the lamp and intersects the lower edge of the louver blades as illustrated in Fig. 11.

Cavity—The enclosed space above the louver grid containing the lamps and accessory equipment; the soffit is generally the permanent ceiling.

Cavity Ratio (D/W)—The proportionality of cavity depth (D), measured from the top of the louver grid to the soffit, to the cavity width (W) perpendicular to the lamp axes.

Cavity Reflectance (R)—The light reflectance of cavity surfaces, obtained with a Baumgartner Light Cell Reflectometer.

Lamp Diameter (L)—The diameter of lamps measured in inches when compared with other dimensions, although lamp diameter is usually given in eighths of an inch.

Lamp Distance (h)—The vertical dimension from the top of the louver grid to the center of the lamp.

Lamp Position (A, B, C)—The position of lamps laterally with respect to parallel reference blades as in Fig. 11.

Random Lamp Position—Results obtained by using an average of A, B and C data weighted $\frac{1A + 2B + 1C}{4}$

Lamp Spacing (S)—The distance between rows of lamps perpendicular to their axes.

Spacing Ratio (S/h)—The ratio of lamp spacing divided by lamp distance.

Efficiency (Output Efficiency)—The ratio of emitted lumens to generated lumens, for the complete element.

Flux Ratio—The per cent of total lumen output which is emitted in the 0°–40° zone; the value is used in determining utilization factors and coefficients of utilization.

and louverall lighting design procedures. As shown in Fig. 12 for white opaque louvers, the effect of shielding angle on efficiency is essentially linear. The solid-line function* for matte finish, established by test data, extrapolates to zero efficiency at 90° shielding. Extrapolation to $\theta = 0°$ indicates an efficiency of 86.5 per cent, which is within three per cent of the open-cavity test value. The discrepancy is caused by loss due to finite thickness of the blades which, for these tests, were fabricated from aluminum 0.025" thick. The present study did not include the effect on output of blades of radically greater thickness.

The proportion of lumens in the 0° to 40° zone to total output (flux ratio) changes more slowly with shielding than does efficiency and tends to change less at the higher angles. This function, which is needed to determine utilization factors, is established over the same range of 20° to 50° by test data and is extrapolated to 10° and to 60°. Were the function extrapolated to 0° shielding, it would indicate a ratio of about 35 per cent as compared to 32 per cent for open-cavity tests. The discrepancy again is a result of blade thickness. The important effect of shielding in modifying candlepower distribution is clearly revealed in Fig. 13.

The effect of varying the lengthwise shielding while holding the crosswise constant was investigated with louvers of 6" × 6" (40° × 40°); 6" × 12" (40° × 22.7°); 6" × 24" (40° × 11.7°); and 6" × 72" cells (assumed to be 40° × 0°). The efficiency (Fig. 14) is linear over the range of shielding tested, but must drop more rapidly toward zero as the shielding angle approaches 90°. These curves are representative of families of curves, each for a different crosswise shielding angle. The slopes of such curves were not determined but are probably similar to those shown. If this is true, the efficiency of differentially-shielded elements may be obtained with a fair degree of accuracy by weighting values obtained from the curves for equal lengthwise and crosswise shielding. Crosswise shielding has the greater effect on efficiency in the ratio of 1.7 to 1. The sum of the weighted values divided by 2.7 is approximately the efficiency of the differentially-shielded louver.

Effect of Shielding Angle on Average Louver Brightness. — Average brightness of the louver grid is calculated by dividing the candlepower of the element by the projected area in the direction of measurement. Results have been converted to footlamberts and adjusted to a reference lamp loading providing an average of 100 lumens generated per square foot of grid. The average brightness within the shielded zone of a louver is reduced with increases in shielding angle, as shown in Fig. 15. Element conditions are the same as in Fig. 12. These same data are plotted in Fig. 16 to show the vertical angular distribution of average brightness for louvers of specified shielding angle. These brightness values apply only for the stated element conditions and lamp loading. In Fig. 17, average brightness values for matte louvers are presented, not for all directions of view, but for crosswise and lengthwise directions with regard to the lamp axis.

Effects of Louver Blade Finish. — Efficiency and average brightness increase and flux ratio decreases as the finish of louver blades becomes more specular. The effect was investigated with three white lacquers of equal total reflectance. One finish was matte and the others glossy. Their reflectance characteristics are indicated in Fig. 18.

The broken-line curves of Figs. 12 and 14 are plotted from data obtained with gloss-finished louvers (type A in Fig. 18). The solid curves apply to matte finishes as noted above. The gloss finish imparts higher efficiency because the specular component reduces the inter-reflection of light within the cells, and between them and the cavity. The

*The significance of the broken-line curves is covered in the discussion of louver blade finish.

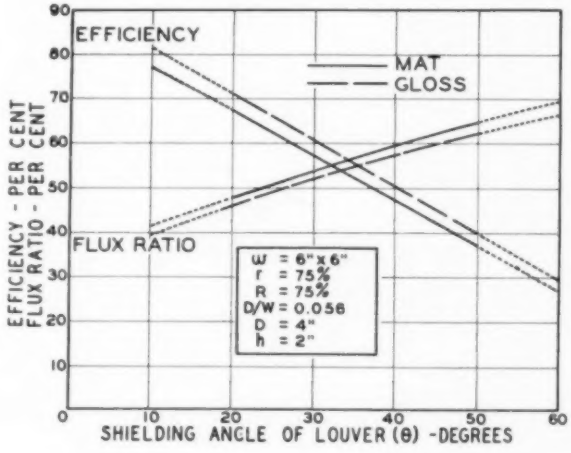


Figure 12. Output efficiency and flux ratio for white opaque louver systems shielded equally lengthwise and crosswise. Gloss blade finishes impart higher efficiency but lower flux ratio than matte.

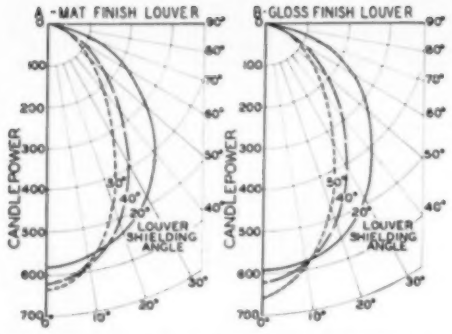


Figure 13. These average candlepower distributions for random lamp position were obtained with 6" x 6"-cell, 75%-reflectance louvers in a cavity of $D = 4'$, $D/W = 0.056$, and $R = 75\%$. Lamp at $h = 2"$. Candlepower for gloss finish is perceptibly higher than for matte, particularly at angles from 40° to 90°.

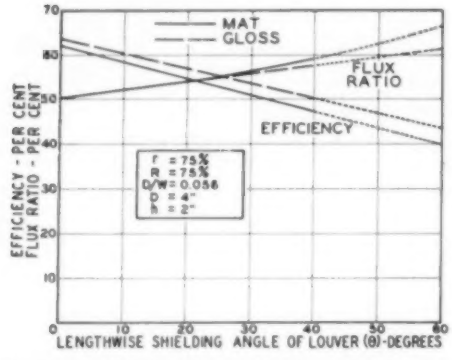
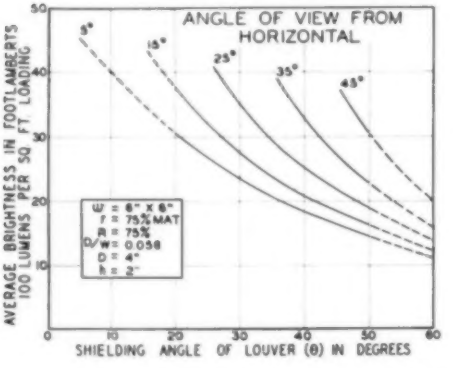


Figure 14. Efficiency and flux ratio for constant crosswise shielding of 40° but varying lengthwise shielding. The increase in flux ratio is about linear for gloss louvers, but for matte finishes, it tends to increase more rapidly at the higher angles, in contrast to the slower increase for louvers with equal lengthwise and crosswise shielding (Fig. 12).



differentials of efficiency and flux ratio caused by finish variations are about constant, proportionately, over the range of shielding angles shown in Fig. 12. In Fig. 14, however, they increase more rapidly at the higher values of lengthwise shielding. The reduction in flux ratio for increased specularity indicates a wider candlepower distribution and higher average brightness in the shielded zone.

For white louvers with shielding equal lengthwise and crosswise, the gloss finish increased brightness over the matte by about 25 per cent when weighted for all directions of view. It also magnified the difference between lengthwise and crosswise average brightness values as shown in Fig. 19. With less inter-reflection, the distribution of light from the source is not as greatly modified and the difference in louver brightness lengthwise and crosswise tends to approach that of the lamp. It is evident that the degree of specularity or spread of each blade finish will determine to what extent efficiency, distribution and brightness results will depart from those obtained with matte surfaces.

Effects of Louver Blade Reflectance. — Previous data have been based on louvers of 75 per cent reflectance, which was assumed to be a conservative value for white. Functions pertaining to efficiency and flux ratio will change in approximately the proportions shown in Fig. 20 for other values of reflectance. An appreciable portion of the lamp output is directly incident upon the louver blades as is a substantial part of the light reflected from the cavity. It is evident from Figs. 12 and 14 that the absorption of light by the grid increases with shielding angle. Hence, the effect of louver reflectance is undoubtedly more pronounced for louvers of greater shielding, and less so for smaller angles. However, the efficiency curve of Fig. 20 provides a reasonable basis for estimates. The relative effects of louver reflectance on efficiency and brightness are shown in Fig. 22. That brightness decreases more rapidly than efficiency with lowered reflectance is important from the standpoint of control of brightness.

Effects of Louver Blade Transmittance. — To indicate the effects of transmission in louver blades, two plastic louvers and one gloss white louver of similar design were tested. Results, together with comparative values for a similar matte white louver, are presented in Table III. Efficiency increased and flux ratio decreased as the transmittance of the translucent blades increased. Both grids showed higher efficiencies than white metal grids. Likewise

Figure 15. Brightness as a function of shielding angle for matte white louvers. Curves based on measurements on louvers with $\theta = 20°$, 40° and 50°. They apply for *all directions* of view.

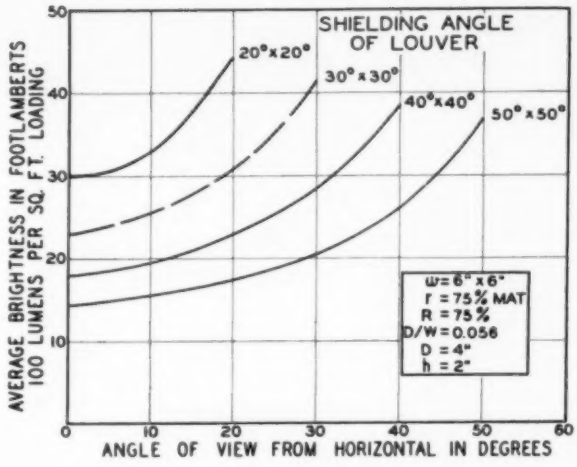


Figure 16. Effect of vertical angle of view on average louver brightness, for specific values of θ (30° curve interpolated). Although the brightness at a given viewing angle reduces more slowly with higher shielding angle, the per cent reduction is more nearly constant.

the candlepower distributions become wider as indicated by lower flux ratios. No attempt is made to correlate efficiency and flux ratio with blade transmittance since the materials varied in absorptance. It will be noted that average brightness increases more rapidly than efficiency due to the wider candlepower curve of the translucent grids. For equal illumination, however, the increase in efficiency reduces the relative brightness differences among the four types of louvers.

In Fig. 23, average brightness values for the plastic and gloss white grids are compared, based on a constant loading of generated lumens per square foot. Increased transmittance results in higher brightness with a proportionately greater increase at angles midway between cut-off and horizontal.

Effect of Cell Size. —— The correlation of efficiency and flux ratio for white cells is shown in Fig. 24. The effect of cell size on efficiency is slight and on flux ratio negligible. Average brightnesses can be expected to vary in proportion to efficiency.

Effect of Cavity Variables

Effect of Cavity Proportion. —— Cavity cross-sections are described by the proportionality of depth to width (D/W) and not by actual dimensions. The validity of this basis was investigated in two series of tests. In the first, square cavities of 18", 36" and 72" width (W) had a fixed depth (D) of four inches. In the second, the width was constant at 72" while the depth varied from 4" to 25". Efficiencies and flux ratios were determined with the light source centered two inches from the cavity soffit. Results are shown in Fig. 25. No point deviates more than 1.2 per cent from the trend established by the six points. The propriety of describing cavity cross-sections in terms of cavity ratio (D/W) was conclusively established for these conditions and assumed valid for others.

For louver and cavity reflectances of approximately 75 per cent, the effects of cavity ratio upon efficiency and flux ratio are shown in Fig. 26. The reference point of unity is at a cavity ratio of 0.056, representing a large shallow cavity often typical of extensive louverall systems. In practice, the presence of ceiling beams and large air ducts tends to increase the effective cavity ratio while smaller items such as conduits and sprinkler systems have less effect. The changes in efficiency and flux ratio with modifications of the cavity ratio are such as to have little effect upon average louver brightness.

Effect of Cavity Reflectance. —— Because of the direct light from the source, output efficiency drops less rapidly than cavity reflectance. The relative effect is shown in Fig. 27 for 40° × 40° white louvers at extreme test-cavity ratios. In deeper cav-

Table III

Summary of Characteristics of Opaque and Translucent Louvers
($w = 2"$; $\theta = 45°$; $R = 75\%$; $D/W = 0.056$)

Louver	r%	t%	Efficiency Per Cent	Efficiency Relative	Flux Ratio Per Cent	Relative Average Brightness 15° from Horizontal	Coefficient of Utilization Wall 50% Floor 14% Index C	Coefficient of Utilization Wall 50% Floor 14% Index I	Relative Average Brightness for Equal Illumination 15° from Horizontal Index C	Relative Average Brightness for Equal Illumination 15° from Horizontal Index I
Matte White*	75	0	40.4	1.00	62	1.00	.32	.22	1.00	1.00
Gloss White**	75	0	43.8	1.08	61	1.15	.34	.23	1.08	1.10
Plastic A	19	71	58.7	1.45	49	2.00	.45	.29	1.42	1.52
Plastic B	25	56	52.4	1.30	54	1.67	.40	.27	1.34	1.36

*Efficiency, flux ratio and average brightness, estimated from Figs. 12 and 15.
**High-gloss finish (B), Fig. 18.

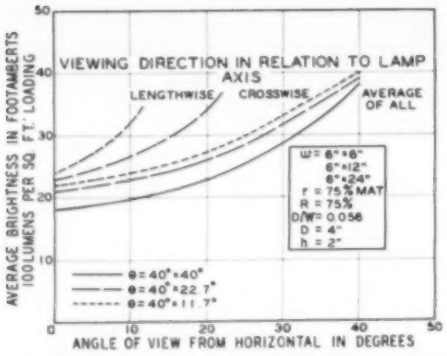

VIEWING DIRECTION IN RELATION TO LAMP AXIS
LENGTHWISE
CROSSWISE
AVERAGE OF ALL
AVERAGE BRIGHTNESS IN FOOTLAMBERTS 100 LUMENS PER SQ FT LOADING
ANGLE OF VIEW FROM HORIZONTAL IN DEGREES
w = 6" x 6"
6" x 12"
6" x 24"
r = 75% MAT
R = 75%
D/W = 0.056
D = 4"
h = 2"
θ = 40° x 40°
θ = 40° x 22.7°
θ = 40° x 11.7°

Figure 17. There is no significant difference between lengthwise and crosswise average brightness with 40° x 40° matte louvers. With differential shielding, the average brightness crosswise increases somewhat as the shielding angle lengthwise is decreased, while the lengthwise brightness increases markedly. Because of the lower shielding angles lengthwise, lamp brightness is seen at angles more nearly horizontal.

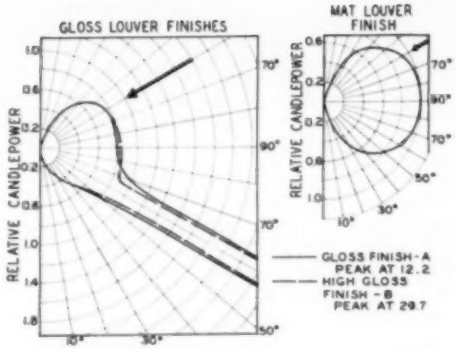


Figure 18. These curves show the relative reflected candlepower from the matte- and gloss-finished white louver blades. Collimated direct light was incident on the blade surfaces at 30° as indicated by the heavy arrows. The high gloss finish (*B*) was used for the 2" x 2" louvers of 45° shielding. The gloss finish (*A*) was employed for all other louvers designated as glossy.

ities, the loss resulting from dark finishes is accentuated. There is no evidence of significant variation with cell size.

There is little effect on flux ratio with either white or black louvers. The ratio for a 6" x 6" matte black louver of 40° × 40° shielding changed only from 84 per cent to 86 per cent when cavity reflectance was dropped from 75 per cent to 4 per cent. Changes in average louver brightness are almost proportional to efficiency.

Effect of Individual Reflectors.—Three types of reflectors in a white cavity—and the cavity without reflectors—are compared in Table IV for four louver grids. The reflectors were of the same cross-section but varied as to surface finish, efficiency, and candlepower distribution as shown in Fig. 29. The finish of the matte white reflector was

Table IV

Performance of Four Louvers with and without Reflectors

R = 75%, D/W = 0.347, h = 15", L = 1" (T8) Louvers			Reflectors (See Fig. 29) None	White	Etched	Specular
Matte White Metal w = 6" x 6" θ = 40° x 40° r = 75%	Efficiency	Per Cent	42.1	42.1	46.9	55.7
		Relative	1.00	1.01	1.11	1.32
	Flux Ratio—Per Cent		66.8	64.2	71.6	72.7
	Coefficient of Utilization*	Index - C	0.33	0.33	0.37	0.44
		Index - I	0.22	0.23	0.27	0.32
	Relative Illumination	Index - C	1.00	1.03	1.12	1.33
		Index - I	1.00	1.05	1.23	1.45
Gloss White Metal w = 2" x 2" θ = 45° x 45° r = 75%	Efficiency	Per Cent	40.6	39.5	44.2	52.4
		Relative	1.00	0.97	1.09	1.29
	Flux Ratio—Per Cent		62.3	60.6	72.9	75.0
	Coefficient of Utilization*	Index - C	0.31	0.31	0.35	0.41
		Index - I	0.22	0.22	0.25	0.30
	Relative Illumination	Index - C	1.00	1.00	1.13	1.32
		Index - I	1.00	1.00	1.14	1.36
Plastic A w = 2" x 2" θ = 45° x 45° r = 19% t = 71%	Efficiency	Per Cent	54.5	52.2	56.3	64.8
		Relative	1.00	0.94	1.03	1.19
	Flux Ratio—Per Cent		51.0	55.2	62.4	64.2
	Coefficient of Utilization*	Index - C	0.42	0.40	0.44	0.51
		Index - I	0.27	0.27	0.30	0.35
	Relative Illumination	Index - C	1.00	0.95	1.05	1.21
		Index - I	1.00	1.00	1.11	1.30
Plastic B w = 2" x 2" θ = 45° x 45° r = 25% t = 56%	Efficiency	Per Cent	45.0	44.6	49.4	57.8
		Relative	1.00	0.99	1.10	1.28
	Flux Ratio—Per Cent		55.8	59.2	65.4	68.6
	Coefficient of Utilization*	Index - C	0.35	0.35	0.39	0.46
		Index - I	0.23	0.23	0.27	0.32
	Relative Illumination	Index - C	1.00	1.00	1.11	1.31
		Index - I	1.00	1.00	1.17	1.39
Efficiency of Reflectors—Per Cent			——	75.3	77.4	87.3
Flux Ratio of Reflectors—Per Cent			——	50.0	65.1	66.6

*Coefficients based on louverall utilization data and 50% wall reflectance.

Table V

Louver Brightness as Affected by Reflectors

Louver	Angle of View from Horizontal	Average Brightness* Footlamberts per 100 Lumens per Sq. Ft.				Relative Average Brightness**			
		Reflectors				Reflectors			
		None	White	Etched	Specular	None	White	Etched	Specular
Matte White	5°	17.5	15.8	15.3	17.2	1.00	.90	.87	.98
Metal 6" x 6"	15°	18.8	16.5	15.8	17.9	1.00	.88	.84	.95
45° x 40°	25°	21.4	18.7	16.7	19.4	1.00	.87	.78	.91
	35°	26.5	22.8	20.1	22.5	1.00	.86	.76	.85
Gloss White	5°	17.8	16.2	15.3	16.5	1.00	.91	.86	.93
Metal 2" x 2"	15°	18.7	16.6	15.8	17.0	1.00	.89	.84	.91
45° x 45°	25°	20.7	18.1	16.8	18.6	1.00	.87	.81	.90
	35°	24.9	23.6	18.6	20.6	1.00	.83	.75	.83
Plastic A	5°	25.2	24.1	22.5	24.1	1.00	.87	.77	.83
2" x 2"	15°	33.0	28.2	25.9	28.0	1.00	.85	.78	.85
45° x 45°	25°	40.6	34.2	30.6	33.6	1.00	.84	.75	.83
	35°	48.5	41.0	36.4	40.5	1.00	.84	.75	.84
Plastic B	5°	21.0	19.5	19.0	20.0	1.00	.93	.90	.95
2" x 2"	15°	24.4	22.5	21.3	22.8	1.00	.92	.87	.93
45° x 45°	25°	29.5	26.3	23.9	26.5	1.00	.89	.81	.90
	35°	35.9	30.9	27.5	31.0	1.00	.88	.79	.89

*Brightness data are averaged for all directions at the specified angle of view.

**Relative values afford comparisons for a given louver and viewing angle, but not between louvers and viewing angles.

almost identical with that of the cavity. In three instances, the introduction of this reflector resulted in slightly lower efficiency. The increase in the case of the matte white louver is within the experimental error and may not be significant although the efficiency of this louver did show the greatest relative increase with other reflectors. Higher flux ratios with the matte white reflector tend to offset losses in efficiency. The more concentrating reflectors result in substantial increases in efficiency, flux ratio, *and utilization*. The louvers having the lower efficiencies in the white cavity tests show the greatest percentage gains.

Effects of these reflectors on average brightness are indicated in Table V for several angles of view. It is evident in Table VI that for a given illumination, substantial reductions in average brightness may be realized through the use of rather concentrating reflectors. Such reflectors offer the unique advantage of simultaneous reduction in brightness, increased efficiency, and even greater increases in utilization.

Effect of Lamps and Channels Considered as Cavity Obstructions.——For reasons presented previously, most tests were conducted with a single 72T8 lamp in the test cavity. The lamp was supported by standard sockets held by friction against the sides of the cavity. No other devices such as conventional wiring channels were used. To investigate the influences of such objects, as well as additional lamps with the cavity, several comparisons were made. Results are summarized in Table VII. Larger obstructions will cause greater losses. Average brightness values appear to vary with output efficiency. No significant differences are detectable in flux ratio.

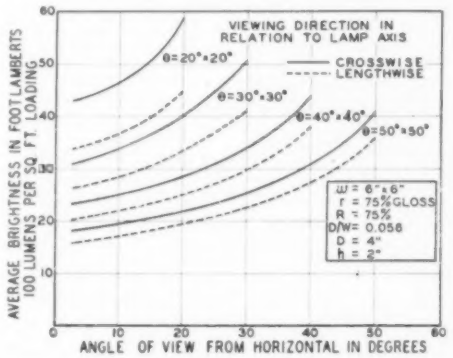


Figure 19. Brightnesses for white louvers, gloss finish, type *B* (Fig. 18). Curve for $\theta = 30° \times 30°$ is interpolated.

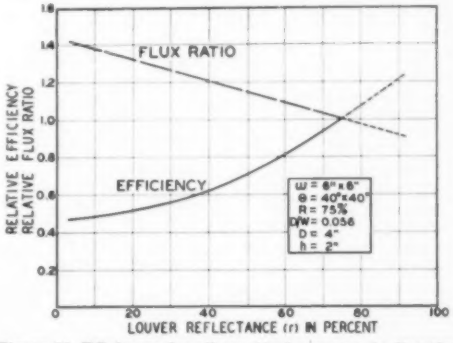


Figure 20. Efficiency, for all practical purposes, is directly proportional to louver reflectance for values exceeding 60%. For lower reflectances, the efficiency drops progressively less. Substantial gains are available with reflectances higher than 75%. Both matte and gloss finishes show comparable relative changes. The effect of louver reflectance on flux ratio is linear over the range investigated.

Tests indicate a slight advantage in efficiency when wiring channels above each lamp are omitted. The appearance of the system, particularly at shielding angles which provide but marginal concealment, is generally improved. There seems to be some economic advantage in eliminating these individual channels in favor of end channels placed at right angles to the lamp rows.

Effect of Light Source Variables

Effect of Lamp Diameter. —— Practice will dictate the use of various lamps; hence, the effect of lamp diameter was explored to a limited extent. Three diameters were used: $L = 1"$ (T8), $L = 1\frac{1}{2}"$ (T12), and $L = 2\frac{1}{2}"$ (T17). The comparisons in Table VIII for random lamp position show a slight trend toward lower efficiency and flux ratio values for the larger ratios of lamp diameter to cell size (L/w). Average brightness values will vary nearly in proportion to output, and the brightness of any well-defined images will be proportional to lamp brightness.

Effect of Lamp Distance. —— Curve A in Fig. 30 shows an intriguing relationship. Efficiency for random lamp position is independent of vertical lamp distance (h) within a fixed cavity if all reflectances are about 75 per cent. Although Fig. 30 is plotted for $6" \times 6"$, $40° \times 40°$ louvers and a cavity ratio of 0.347, the effect was found to hold for other cell sizes, shielding angles, cavity ratios and for both matte and gloss louver finishes. As the reflectance of the louvers or the cavity is decreased, higher values of h result in a loss of efficiency.

Effect of Lamp Position. —— The proportionalities among the dimensions of w, L and h determine whether or not specific lamp positions will produce significant differences in performance. As w increases, or L or h is decreased, the possibility of variations in efficiency with specific lamp position becomes greater. In Fig. 31, typical efficiencies, relative to those for random lamp position, are plotted against the ratio of L/w for 1" lamps in A and C positions. The A position affords maximum output efficiency with a given louver design while the efficiency at C tends to be lower than for random lamp position. Flux ratio may be slightly higher for A and lower for C.

Whereas most functions involving variables L, w, h and efficiency appear to be simple and consistent for *random* lamp positions, they often become complex when *specific* lamp positions are considered. For example, there is experimental evidence that the function between efficiency and the ratio of L/w is more complicated than suggested by Fig. 31. For the summary in Table IX, w and h are constant at 6" and 2" respectively. Values for the larger diameter lamps in the A position fall above the $40° \times 40°$ curve in Fig. 31. Also, the effi-

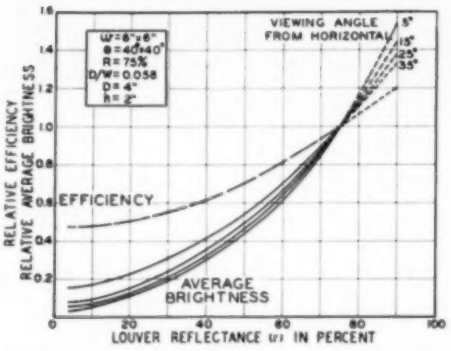


Figure 22. Louver reflectance affects average brightness more than efficiency. Actual brightnesses corresponding to the relative value of 1.0 are found in Fig. 21 at 75% reflectance for the four selected viewing angles.

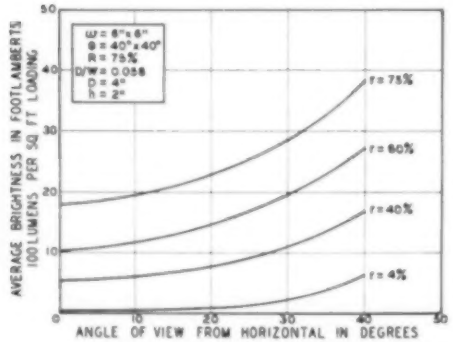


Figure 21. Matte louver brightness for four blade reflectance values at varying angles of view. Values are averages for all directions of view with regard to lamp axis.

Table VI

Data in Table V Adjusted for Equal Illumination

Louver	Room Index	Relative Brightness at 15° to Louver Plane for Equal Initial Footcandles* Reflectors			
		None	White	Etched	Specular
Matte white Metal 6" x 6"—40°	C	1.00	.88	.75	.71
	I	1.00	.84	.68	.65
Gloss White Metal 2" x 2"—45°	C	1.00	.89	.74	.69
	I	1.00	.89	.74	.67
Plastic A 2" x 2"—45°	C	1.00	.89	.74	.70
	I	1.00	.85	.70	.66
Plastic B 2" x 2"—45°	C	1.00	.92	.78	.71
	I	1.00	.92	.74	.67

*Relative values afford comparisons for a given louver and room index but not between louvers and room indices.

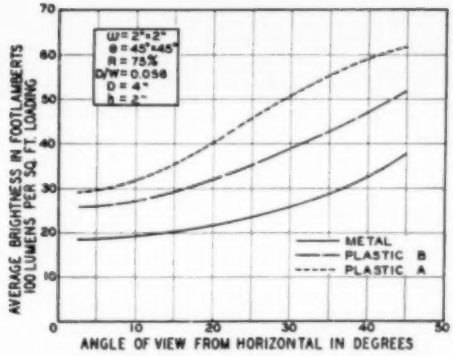


Figure 23. Average brightnesses for two plastic louvers and one gloss white metal. Louvers are described in the text and in Table III.

ciencies for A and C positions show departures from those in random lamp positions as the factor h is decreased to less than the cell size. In tests with T8 lamps and 3" and 6" cells of 40° × 40° shielding, the differences in efficiency become negligible when h/w equals 1.0-1.2 or more. Many additional measurements would be necessary to explore and define detailed inter-relation of these factors.

Some insight into these relationships may be had through an analysis of the geometry of lamp diameter, distance, position and shielding. Fig. 6A, (Part I), illustrates how the shielding angle ϕ for a lamp in an A position may be greater than the louver shielding angle θ. The bulb diameter (L) must be smaller than the projection of the louver blade along the louver shielding angle. The lamp shielding angle ϕ is alternately equal to and greater than θ as the lamp moves upward. Similar fluctuations occur in the C position. The values of h for maximum shielding at each step may be calculated from the equation:

$$h = K \times w \times \tan\theta - \frac{L}{2\cos\theta}$$

in which, for the A position, K is any integer and, for the C position, it is any odd multiple of 0.5. The actual shielding angle ϕ for each step is calculated by the equation:

$$\phi = \tan^{-1}\left(\frac{w\tan\theta + h}{Kw}\right) - \sin^{-1}\left(\frac{L}{2\sqrt{(w\tan\theta + h)^2 + (Kw)^2}}\right)$$

The difference between ϕ and θ at each step decreases as h increases. If, as in Fig. 6B (Part I), the lamp diameter is larger than the louver blade projection, ϕ is always equal to θ since the lamp is considered unshielded if any part of it is visible at the selected louver shielding angle. The minimum cell size below which there can be no difference in lamp shielding angle (ϕ) and the louver angle (θ) is determined from the equation:

$$w = \frac{L}{\sin\theta}$$

Designs based on specific rather than random lamp positions usually have advantage from the standpoint of appearance. Unless lamps are consistently positioned with respect to the louver blade pattern, lamp shielding angles are likely to vary. If the variation is marked—as it may be with large cells, small lamp distances and shallow shielding—the effect is annoying to anyone moving about the area.

Table VII

Effect of Channels and Additional Lamps
(w = 3" and 6"; θ = 40° x 40° and 50° x 50°; r and R = 75%; D/W ratio varied from 0.056 to 0.347)

Number of Lamps	Lamp Spacing in Inches	Channels Used	Relative Efficiency*	Reduction in Per Cent
1	centered	No	1.00	1.5
1	centered	Yes	0.985	
1	centered	No	1.00	2.5
6	12	No	0.975	
6	12	No	0.975	3.6
6	12	Yes	0.940	
1	centered	No	1.00	6.0
6	12	Yes	0.940	

*Values for more than one lamp in the test cavity are probably conservative; losses are undoubtedly higher than for many louverall systems due to relatively close spacing between lamps and from lamps to cavity sides.

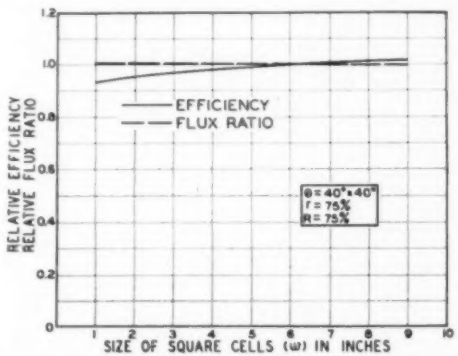


Figure 24. Effect of cell size (w) on efficiency and flux ratio. For gloss and matte louvers, with four cavity ratios (D/W), and random lamp position. Effect is less with smaller shielding angles because less light is intercepted by the blades.

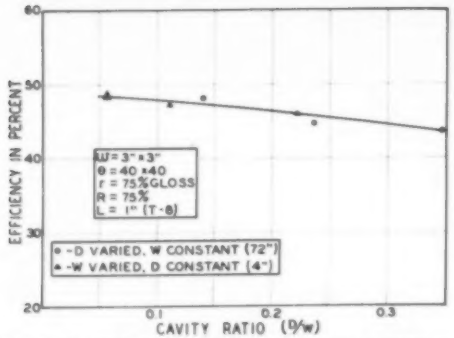


Figure 25. Variation of either cavity depth or width to produce different cavity proportions gives a like result in efficiency. Chart applies to weighted average (random) lamp position; each point represents an average of three tests.

Utilization Data and Calculations

Coefficients of utilization for wall-to-wall louverall systems were obtained in a model room six feet square. The height was varied to provide room index values of C, E, G and I. Reflectances were 14 per cent for the floor and 50 per cent, 30 per cent or 10 per cent for walls. Louver grids were selected for a fairly wide range of flux ratios. Room height, for determining room index, was measured to the bottom of the louver grid. Illumination measurements were made with a color- and cosine-corrected multi-cell precision light meter. From these results, the empirical coefficients of utilization plotted in Fig. 32 were derived.

Since these data alone do not provide a complete design system, the ordinates are divided by the output efficiency of the respective louver elements to obtain *utilization factors* which relate to the distribution of candlepower only. Such values are plotted in Fig. 33. Rigorously, these curves represent many others, each of which pertains to a different effective ceiling reflectance, but differences are negligible in practice.

The flux ratio values presented in this paper are employed as abscissae in Fig. 33 to obtain utilization factors. These, in turn, are multiplied by the corresponding element efficiencies to obtain *coefficients of utilization* which apply to louverall systems co-extensive with the room area. Efficiency and flux ratio values may also be used to determine

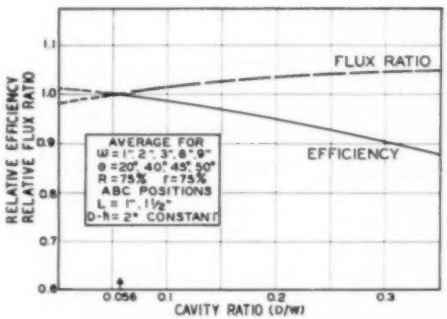


Figure 26. Effect of cavity proportion on efficiency and flux ratio as established from 86 tests covering a wide range of cell size, shielding angles and finishes. Extrapolations toward zero indicate performance of cavities approaching infinite extent. Reference ratio of 0.056 is generally used in other analyses.

Table VIII

Effect of Lamp Diameter on Efficiency and Flux Ratio

D/W	D	h =	h		Lamp Diameter L = 1" (T8)	L = 1½" (T12)	L = 2½" (T17)
Louver: w = 6" x 6", θ = 40 x 40, r = 75% matte Cavity: R = 75%							
0.056	4"	0.33"	2"	Efficiency	47.3	45.2	45.5
				Flux Ratio	59.5	59.0	58.1
0.347	25"	3.83"	23"	Efficiency	41.5	39.5	39.2
				Flux Ratio	62.5	61.5	61.7
		0.33"	2"	Efficiency	49.7	49.0	49.1
				Flux Ratio	60.0	60.0	59.5
Relative efficiency, average of 7 tests					1.00	0.96	0.96
Relative flux ratio, average of 7 tests					1.00	0.99	0.98
Louver: w = 3" x 3", θ = 50 x 50, r = 75% matte Cavity: R = 75%							
0.056	4"	0.66"	2"	Efficiency	37.2	35.8	.....
				Flux Ratio	64.3	64.8	.....
0.347	25"	7.67**	23"	Efficiency	33.1	31.6	.....
				Flux Ratio	67.6	67.4	.....
Relative efficiency, average of 4 tests					1.00	0.96	.....
Relative flux ratio, average of 4 tests					1.00	1.00	.....

*Data are averages of 3 tests, with lamp in A, B and C positions.

**Data are from 1 test, with lamp in B position.

the somewhat higher coefficients of utilization for small elements conventionally spaced. For this purpose, the basic data of Harrison and Anderson[1] and subsequent extrapolations are used.

The coefficient of utilization for a louverall system is employed in the conventional illumination design equations:

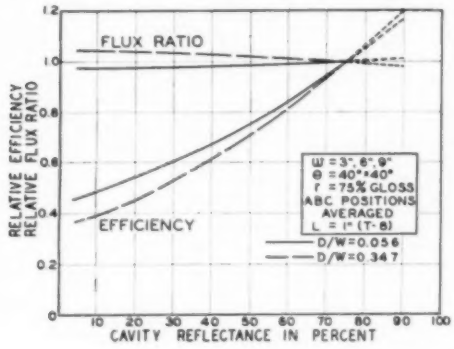
$$\text{Footcandles} = \frac{\text{Initial lamp lumens} \times \text{Coefficient of Utilization} \times \text{Maintenance Factor}}{\text{Room Area}}$$

or,

$$\text{Initial Lamp Lumens} = \frac{\text{Footcandles} \times \text{Room Area}}{\text{Coefficient of Utilization} \times \text{Maintenance Factor}}$$

As with other luminaires, there is an accumulation of heat which usually reduces the light output of fluorescent lamps. The general effect has been investigated by Forbes and Diefenthaler,[2] although

Figure 27. Efficiency and flux ratio of white louver systems as affected by reflectance of cavity surfaces. Since flux ratio remains almost constant, there will be little change in the shape of candlepower distribution curve.



their studies did not include louverall types. Photometric data for luminaires of fixed design usually take this reduction into account, but the variation in efficiency, ballast location, ventilation and wattage loading of louverall systems is so great that no attempt is made to incorporate this factor in the efficiency data herein. The designer should make allowance for heating effect.

[1]Coefficients of Utilization, by Ward Harrison and Earl A. Anderson, *Transactions I.E.S.*, Vol. XV, p. 97 (1920).*

[2]Effect of External Factors on Light Output of Fluorescent Sources, by J. C. Forbes and R. J. Diefenthaler, ILLUMINATING ENGINEERING, Vol. XLI, p. 872 (1946).

*(For complete Bibliography, see Part I).

Table IX

Efficiency and Flux Ratio for Lamp Positions A and C Compared with Random Lamp Position

(For Two Cavity Ratios and Three Lamp Diameters)

(Louver: White Opaque; $w = 6''$; $\theta = 40° \times 40°$)

h/w	D/W	L	L/w	Relative Efficiency for Indicated Lamp Position			Relative Flux Ratio for Indicated Lamp Position		
				Random	A	C	Random	A	C
0.33	0.056	1 "	0.167	1.00	1.07	0.98	1.00	1.01	1.00
		1½"	0.250	1.00	1.04	0.99	1.00	1.01	1.00
		2⅛"	0.354	1.00	1.05	0.99	1.00	1.02	0.99
	0.347	1 "	0.167	1.00	1.07	0.98	1.00	1.01	1.01
		1½"	0.250	1.00	1.07	0.98	1.00	1.00	1.01
		2⅛"	0.354	1.00	1.05	0.99	1.00	1.02	1.00

Maintenance factors for louverall as yet are not established. They are probably comparable with those for similarly louvered luminaires. Since control of brightness is a major objective in the design of most louver systems, calculations should include a check on the average brightness at viewing angles of particular interest. The values given in this paper are based on a loading of 100 lumens generated per square foot. These basic values should be modified for actual lumen loading and for louver or cavity conditions other than those indicated in charts.

The authors are indebted to Messrs. R. H. Haase, H. E. Schultz and W. R. Stephens who have performed the tedious work of making and computing the large number of photometric tests required.

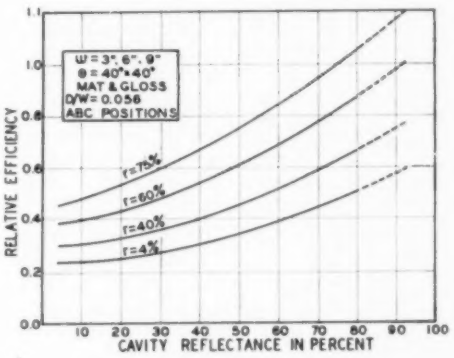


Figure 28. The combined effect on efficiency of changes in cavity and louver reflectance. The curve $r = 75\%$ and all points for $R = 75\%$, and the single point for r and $R = 4\%$, are established by test data. The shape of all curves is assumed to be directly proportional to that for $r = 75\%$. For a larger D/W ratio, the losses in efficiency would be even greater as suggested in Fig. 27.

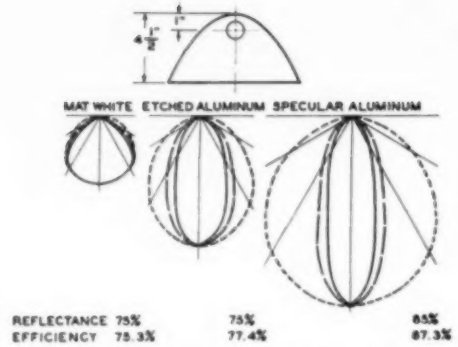


Figure 29. Relative candlepower distribution from T-8 lamp in reflectors of parabolic cross-section, 1" focal length and three surface finishes. Planes of candlepower distribution wtih respect to the lamp axis: solid curve-perpendicular; long-dash—45°; short-dash—parallel.

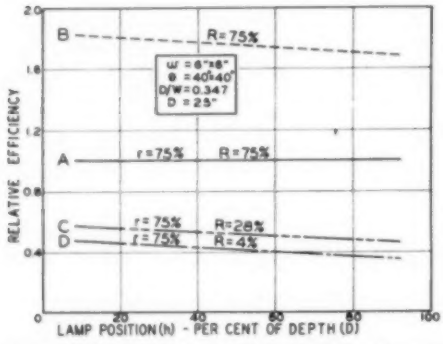


Figure 30. Typical effects on efficiency resulting from vertical displacement of lamps, at random position laterally, in a cavity of fixed proportion. The efficiency is constant when all reflectances are 75% (Curve *A*). Curve *B* shows the trend for the cavity without a louver, while Curves *C* and *D* are for white louvers in cavities of 28% and 4% reflectance, respectively. The constant result of *A* must be attributed to the inter-reflection of light.

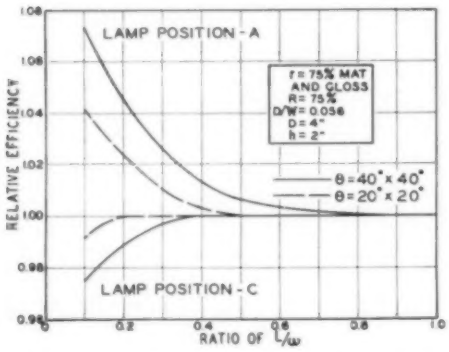


Figure 31. Efficiencies for A and C lamp positions relative to that for the corresponding random lamp position. Tests with T-8 lamps and varying cell sizes. For $\theta = 40°$, the departure of A position values from average becomes negligible when L/w is about 0.4; for C position at about 0.2. Departures are still less at $\theta = 20°$ for the A position and are insignificant for C. As h/L increases, the differences are reduced.

DISCUSSION

GEORGE E. SHOEMAKER:* Interesting variations of the louverall ceiling have been built. Two of Philadelphia's largest high schools each have an auditorium with a louvered ceiling, above which maintenance men walk about to replace lamps. Since all children face the stage, we slanted the transverse louvers about 25 degrees and painted the side toward the eyes grey, to reduce brightness. Since the design called for bowl-silvered or bowl-enamelled lamps, the system is properly designated as asymmetric indirect lighting, or drifted indirect. There are few installations of effective indirect lighting from a ceiling that appears dark. This one is thirteen years old.

In the paper, the authors assume all lamps parallel to louvers (to simplify their analysis) and their shielding angles are definite. In two of the four louvered systems with which I am familiar, the lamps are at an angle of about 30 degrees, and the shielding angle varies with the direction of the line of sight. At a local Regional Conference, a speaker on louveral ceilings appeared never to have heard of this variation—which suggests that the matter be given more place in our discussions. Slanting the lamps has marked advantages under certain conditions, as the authors have no doubt learned.

The authors' statement that maintenance factors are not yet established is important. One louver installation near my office, which meets requirements for good engineering design, operates at a very low efficiency: one test showed 7.8 per cent of the generated lumens arrived on the "working plane." In addition to the matter of efficiency maintenance, lamp servicing is a large factor. In studying any lighting problem, when we find (as we frequently do) that 15 per cent of the lamps in a factory or store are blinking or burned out, we design the next area in the building accordingly. If the percentage is 30 per cent, as it sometimes is, that is allowed for. At present, I am assuming that lamps in less accessible sockets, such as those above louvered ceilings, will average 30 per cent to 50 per cent burned out, depending on the maintenance procedures of the individual client. I base my designs on what my lightmeter tells me in the places I go from day to day, because I believe that to be good engineering.

There is sometimes no existing job from which to get facts, and we are grateful accordingly to Mr. Potter and Mr. Oetting for their work in providing much needed design data. It is well presented and it is arranged for easy use by designers. Congratulations to them!

W. M. POTTER:** Mr. Shoemaker points out the still more comfortable louver and ceiling brightness achieved by tilted

*Philadelphia Electric Company, 100 Chestnut St., Phila. 5, Pa.
**Author.

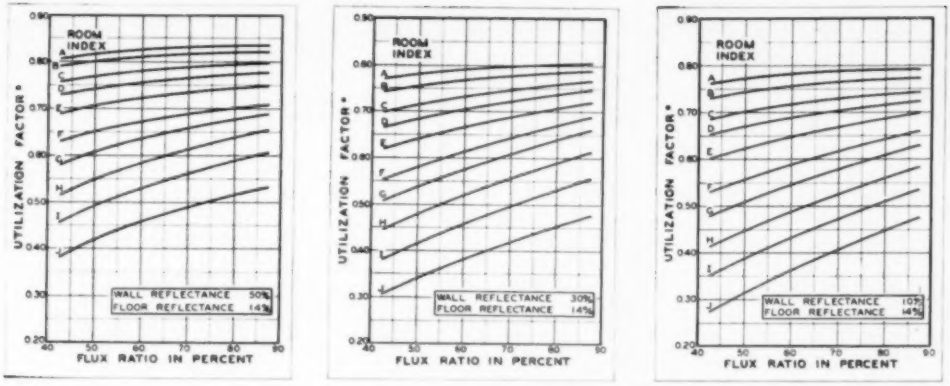


Figure 33 (A) (B) (C). Utilization factors for wall-to-wall louverall systems. Curves for room indices of *H* through *C* are derived from the experimental data of Fig. 32. Curves for indices *A*, *B*, and *J* are extrapolated. (*Note that utilization factor must be multiplied by the output efficiency of the element to obtain coefficient of utilization.)

louvers. We would emphasize again that this appears as well in the form of much reduced brightness of images in specularly reflecting work surfaces.

Results obtained in appearance and shielding from oblique placement of lamps with respect to square louvers can, alternatively, be duplicated by angular orientation of the cells or by making them of diamond shape.

The authors do not present louverall as a lighting panacea; we undertook only to evaluate quantitatively, so far as practicable, the factors bearing on the design of louver systems, which have found a useful place in the techniques of lighting.

As with all lighting systems, maintenance, and ready facilities therefor, are essential. Wholly inadequate maintenance may contribute to the low overall utilization (7.8 per cent) obtained in the installation described by Mr. Shoemaker. Further, I understand that this was the ceiling of a 20-ft x 6-ft show window. In such case, the narrow space and glass walls would not be conducive to high utilization except with the most directive equipment. We suggest, for such circumstances, that a combination of suitably tilted blades and controlling reflectors would result in substantial improvement.

Mr. Twitchell's comments** on the effect of cell size on concealment are of great interest. Since one cannot see through a cell regardless of size from points within the shielded, angular zone, the differences in impression doubtless result from at least two factors: (a) a possible tendency to look up into the larger elements; and (b) the effect of the smaller cells in breaking up the obtrusive elements above.

I would like to emphasize one point particularly as regards any louver or louverall system. Most steps to provide higher efficiency tend to widen the candlepower distribution, and thus, the moderate gain in utilization inadequately compensates for the more marked increase in brightness. However, with the use of reflectors of more or less concentrating type, simultaneous improvement in all three respects may be realized. In fact, utilization gains *faster* than output, and brightness is materially reduced for equal loading or for equal illumination.

**Not furnished for publication.

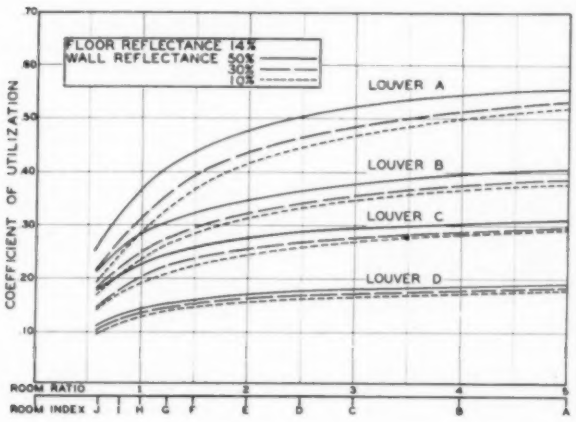


Figure 32. Experimental coefficients of utilization obtained with four louver grids in a model room 6′ square. The element contained six 72T8 lamps on 12″ centers. Louver A: 6″ x 6″, 20° x 20°, r = 75% gloss. Louver B: 3″ x 3″, 40° x 40°, r = 75% gloss. Louver C: 3″ x 3″, 50° x 50°, r = 75% matte. Louver D: 6″ x 6″, 40° x 40°, r =4% matte.

Adapters Remodel

(Left) *Before.* Bare lamps in ceiling of this dining room are neither pleasing nor effective. Close-up shows adapter which may be used for improving appearance and general lighting.

GLARING lamp bulbs need no longer plague the average American family. Adapter fixtures which can be readily installed in existing sockets are once more being manufactured. Such equipment will be of greatest interest to the family desiring better lighting with a minimum of expense. In most cases the use of adapters does not involve rewiring, plastering or redecorating.

Ceiling fixtures designed for one or more "bare" lamp bulbs have long been a problem in the average home. They have been used in innumerable places—dining rooms, kitchens, bedrooms, halls, as well as basements and garages. From a lighting standpoint they present an impossible combination. With lamp bulbs of suitable size to produce adequate lighting, glare becomes unbearable. When glare is reduced by the use of smaller lamp bulbs (and usually of the colored variety) the

Miss Buchholtz is Home Lighting Consultant with the Westinghouse Electric Corp., Lamp Division, Bloomfield, New Jersey.

(Above) *After.* Application of silvered bowl lamps and two clip-on adapters add note of interest to the room. Larger dining room fixtures may use three or four adapters. Its six-inch-diameter size makes this unit also usable in single socket ceiling outlets in smaller areas of the home — entrance halls, dens and bathrooms.

(Below) This photograph of a typical bedroom shows a definite deficiency of light "where you need it." The bare lamp in the ceiling canopy gives a hot spot of light even with a small bulb, while a very short dresser lamp affords meagre light on one side of the face only. In the after-view (facing page), a pair of certified (CLM) dresser lamps provide a good diffusion of light "at cheek level."

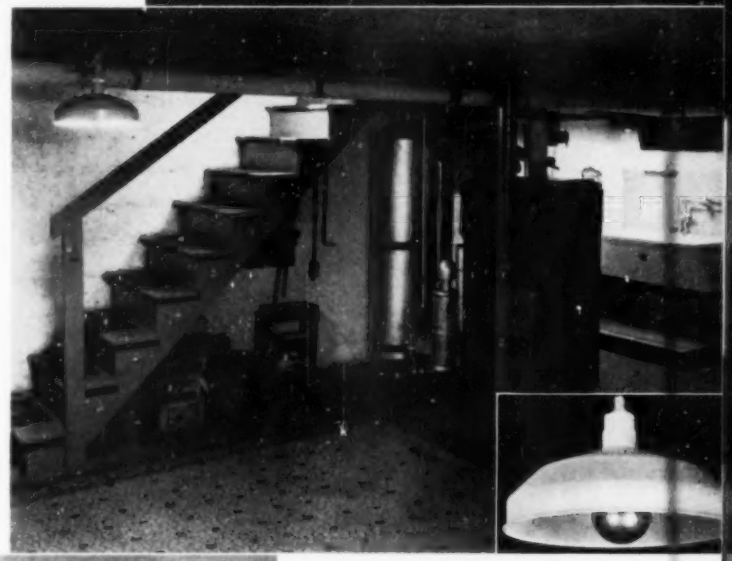
Home Lighting

By EDITH L. BUCHHOLTZ

lighting results are meager. It is small wonder that many families, a decade or so ago, eliminated this type of fixture from their living room, plastered over the center ceiling outlet, and selected instead the softer, more comfortable lighting furnished by portable lamps—with shades!

However, even with the extended use of portable lamps, there remains an undercurrent of desire and preference for good general illumination from ceiling fixtures. For the tenant or the thrifty home owner, adapter equipment can play a predominant role in the improvement of existing lighting installations.

The simplest and least expensive type of adapter is the "clip-on" shield. In addition to paper parchment shades, "clip-ons" are now manufactured from translu-



(Below) The general lighting effect is considerably softened by the use of a plastic clip-on adapter, in this after-view of the same room. The basic cup section around the lamp is white to avoid a discolored lighting effect, but rims come in different colors.

(Above) The photographs above illustrate before and after views of a typical basement—usually the center of many family work and recreation activities.

Before. **Bare lamps near the stairway can create a hazard of blinding glare—the cause of many home accidents. At work centers, such as shown at extreme right of photo, they produce a harsh and uncomfortable lighting effect.**

After. **Basement achieves more livable qualities with correct lighting. Light from a silvered bowl lamp is directed downward by the matte white reflector lining of this "screw-in" adapter (see inset). This utility unit is excellent for lighting workbenches and laundry centers, attics and garages.**

cent plastic materials. Many of the new styles reflect the shallow, more streamlined designs of today instead of the bowl-like shapes of pre-war days. Thus for their most successful use, they should be installed in sockets close to the ceiling. However, this does not eliminate the possibility of their use on drop cord fixtures since the cord may be readily shortened and the original socket rewired.

One clip-on adapter unit is designed to use a 60-watt silvered bowl lamp bulb, thus giving a pleasant effect of indirect lighting. It is particularly successful in the room with a white or very light-colored ceiling. Of necessity clip-on adapters must be limited as to weight since they are suspended on the lamp bulb by only a wire clamp. This basic factor greatly influences the design, material, and size of the clip-on type of adapter.

To meet the demands for larger, sturdier, and better light producing adapter fixtures, the "screw-in" type of unit designed to use 100, 150 and 200 watt silvered bowl bulbs is now available. A sturdy mounting is assured since the top end of the suspension husk of the adapter is threaded to intermesh securely with the medium base ceiling socket. The lower end of the husk conceals the rod supports of the fixture body and the socket for the lamp bulb. While the basic control of light is provided by the silvered bowl lamp, adapter designs vary from the utilitarian reflector providing diffused down light for laundry, basement and garage to decorative units providing indirect light for any of the living areas of the home.

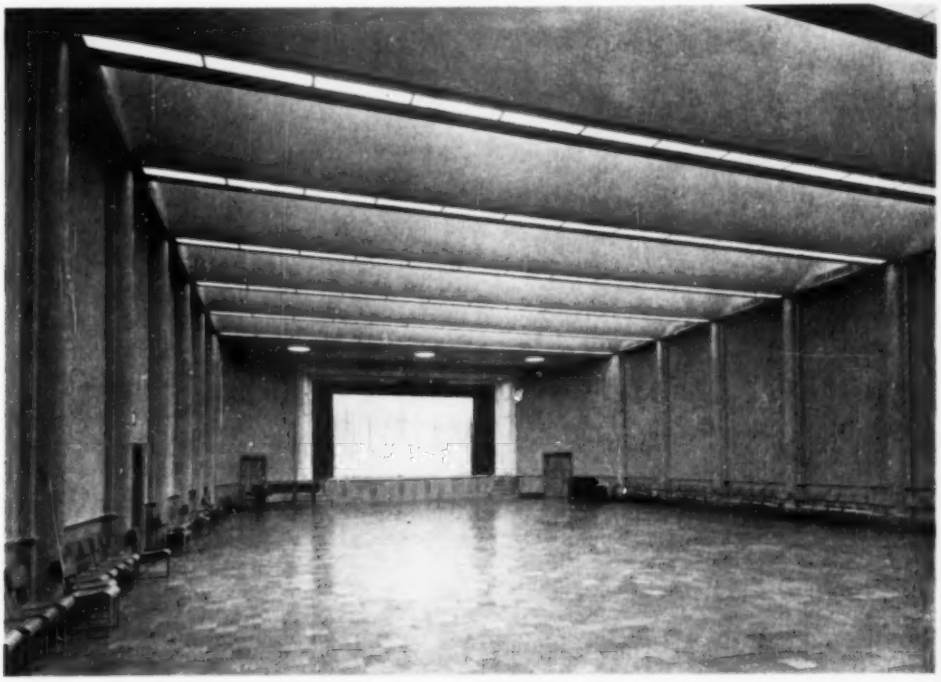
It is not even suggested that adapters should be compared with highly styled, permanently installed and more expensive fixtures designed for good lighting. However, the simple functional designs of adapter units present a pleasantly unobtrusive appearance and offer a quality and efficiency of lighting which is generally far superior to that obtainable from many permanently installed, but poorly designed, lighting fixtures.

Practically all of the adapter designs are also available in permanent type fixtures. However, it is the adapter units which are of greatest interest to those who desire comfortable, pleasant lighting without undertaking the task of major home remodeling.

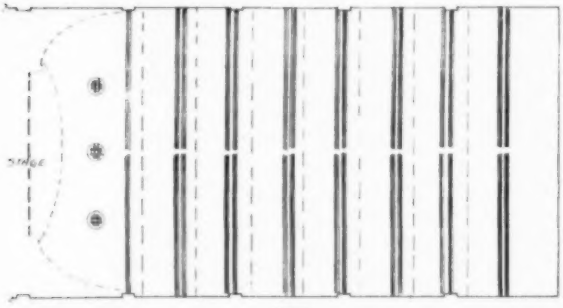
A second floor hall "comes to life" when one of the larger silvered bowl adapters of screw-in design replaces a bare lamp bulb. This and similar units — some simpler, some more ornate in design — produce satisfying results in living rooms, dining rooms, kitchens, bedrooms and utility rooms. A white or very light ceiling makes the most effective reflecting surface for this indirect lighting adapter.

Lighting an Auditorium

LIGHTING OBJECTIVE: To light the main body of the auditorium of a large war veterans' hospital so that it may be used for stage productions, dancing, card playing or other social functions.



Installation at Sunnybrook Hospital, Sunnybrook Park, Toronto, Ontario, Canada.



General Information: The area is approximately 55 feet by 100 feet with a 20-foot ceiling. The sidewalls are rough beige tapestry (35 per cent reflectance); the ceiling is smooth cream plaster (75 per cent reflectance); and the polished oak floor has a 25 per cent reflection factor.

Installation: General lighting is provided by approximately 2400 feet of 3500K cold cathode fluorescent tubing operated at 60 milliamperes and installed in three-lamp coves and troffers. There are thirty 375-watt units connected for three-phase opera-

(over)

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tion. At the front of the auditorium are three round, flush units each containing twenty feet of cold cathode tubing. Both these and the troffers are covered with flashed opal glass. All units are controlled by dimmers. Complete stage lighting is installed but not shown here.

After approximately 1000 hours of operation the average illumination on a horizontal plane 30 inches above the floor was as follows:

Coves only	5.25 footcandles
Troffers only	6.82 "
Coves plus troffers	14.6 "

The brightnesses measured

	Ceiling (center of coves)	*Walls* (10 feet above floor)
Coves only	10 footlamberts	2.5 footlamberts
Troffers only	1.4 "	1.25 "
Coves plus troffers	11 "	4.1 "

Troffers at	45°	198 footlamberts
" "	30°	131 "
Round units at	45°	221 "
" " "	30°	228 "

Equipment manufactured by the Q.R.S. Fluorescent Lighting Corporation.

Architects: Allward and Gouinlock

Associated Consulting Engineers: H. H. Angus and R. P. Allsop

Lighting data submitted by D. J. McKenzie, Toronto Hydro-Electric System, Toronto, Ontario, Canada, as an illustration of good lighting practice and to aid in the design of similar installations.

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Controlled Beam Lamps for Street Lighting

By ALBERT ZACK
EARLE D. BENSON

THE development of the hard glass reflector lamp has been the most outstanding advancement of incandescent lamps in recent years. The wide acceptance of this type of lamp is proof of its effectiveness in controlling generated light into beams of predetermined patterns. In particular, the sealed beam automobile headlight lamp has shown how well light can be projected in narrow, well defined beams.

It seemed reasonable, therefore, to consider the same type of lamp for a parallel lighting application—namely, the illumination of streets and highways, particularly those not in the white way or super-highway categories. Such considerations as simplicity of installation, permanence of reflector surface and therefore better maintenance of lumen output, minimum effect of atmospheric dust and other deteriorating conditions, and low overall cost for delivered light has resulted in the development of a line of PAR-38 street lighting lamps.

Essentially the PAR-38 street lighting lamp consists of a deep upper reflector sealed to a refractor lens cover plate, forming a globe just under 5 inches in diameter. An early decision revolved around the optical goal. It was felt that a distribution approximating the I.E.S. Type II (narrow asymmetric distribution) would best achieve desired results. One limiting factor was that a 5-inch bulb is not entirely practical with wattages over 200-250. Both the 1000 and 2500-lumen street lighting lamps fall within this range and these sizes are primarily used for residential thoroughfares, secondary business streets and rural highways. The I.E.S. Type II distribution revolves around two narrow beams of light with the maximum candlepower approximately 75° above the nadir and laterally displaced between 5° to 12° from the curb line. Implied also in this distribution is vertical and lateral control of light towards the house and street side.

Figs. 1 and 2 show the distribution achieved in handmade samples of 6.6-ampere series 2500 lumen size—a pattern effective enough to be used as the basis of production molds now being fabricated. The final lamps will, it is believed, approximate this distribution very closely.

The PAR street lamp has been developed through an evolution of design in a way similar to the step by step improvements of the sealed beam headlights. The optical requirements in the street lamp are more complicated because of the relatively large filament in a small reflector. To achieve the desired distributions the lamp is designed with the filament mounted well up into the reflector and in this way a 55° cut-off is obtained. The reflector is essentially parabolic in shape with the contour modified by steps which are designed to help shape the asymmetric distribution. To the reflector is sealed the refractor lens which contains a series of radial prisms that collect and lift the rays to form the distributions shown.

Any unit that will be used in residential areas must take into consideration the distribution of light towards the houses. Although some light is

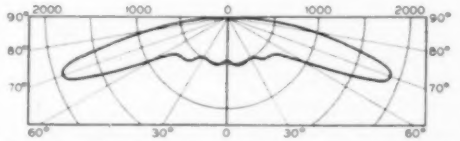

Figure 1. PAR street lamp, 2500-lumen, 6.6-ampere, in maximum vertical planes. Preliminary photometric curve of the vertical distribution in the plane of maximum candlepower.

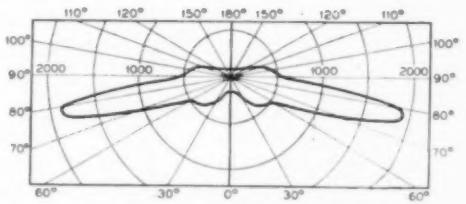

Figure 2. PAR street lamp, 2500-lumen, 6.6-ampere, in cone 70° up from vertical. Preliminary photometric curve of the lateral distribution in the cone of maximum candlepower.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 19-24, 1948, Boston, Mass.
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desirable on porches, too much light at high angles towards second story windows can be annoying. For this reason the cut-off of light from the PAR street lamp is lowered to 55° on the house side and 65° on the street side.

Fig. 3 shows a picture of a field test installation. The 30-foot wide street is lighted with 6.6-ampere series 2500-lumen PAR street lamps which are spaced 180 feet on one side and mounted at a height of 25 feet.

The illumination pattern is indicated by the measured values inserted on the photograph. These are illumination values and because of the specular nature of the road surface do not follow the brightness pattern as seen at the angle the photograph was taken. One important point to be stressed is that there is very little depreciation in these values due to the fact that the lamp is practically unaffected by external conditions.

In many cases the spacing of light fixtures is necessarily quite far apart. Therefore, to attain any reasonable degree of uniformity of illumination on the street it is necessary to provide a strong beam of light. However, to send a strong beam of light towards the motorist means that the driver will be exposed to a bright unit. This technique of street lighting poses a serious problem in brightness control, especially for units designed for use at great spacings. The present trend towards higher mounting heights is helping materially by moving the light source further away from the line of sight.

It is believed that in the PAR street lamp the direction of the main beam (12° from the normal line of sight) plus the restricted lateral distribution provides adequate shielding of the main beam brightness while the small size of the unit helps to make the lamp less noticeable to the driver. In addition a sharp cut-off is provided at the higher angles to reduce the light which is directly in line with the driver's line of sight.

The present units are designed for both 1000 and 2500 lumens nominal and for either 6.6-ampere series or 120 volt multiple operation. Other ratings are being investigated but as pointed out previously the PAR-38 lamp is limited in the wattage it can handle. One likely possibility for higher output is to use two lamps in one fixture which in addition to providing better distribution and increased illumination would provide a safety factor for group replacement programs where penalties are imposed when lamps are burned out.

Even though present day concepts of street lighting are centered around a main punch of light along the street, there is still a great demand for a symmetrical distribution (I.E.S. Type V) especially in newly developed sections where the only lighting done is at street intersections. At present only the asymmetric lamp is ready for release. However, work is being continued to provide a PAR street lamp which will produce a symmetrical distribution of light. This lamp will be made in the same sizes as the asymmetric lamp.

In any concept of asymmetric distribution orientation is fundamental. Since in this case the light source and luminaire are one integral part, orientation must be achieved with the base of the lamp. This orientation is obtained only with difficulty using the ordinary screw base. If difficult orientation is left for relamping it is likely to be omitted or not done correctly.

An effective solution has been provided for the series lamp by designing a base with cut-out prongs similar to those used in the universal series socket adapted (See Fig. 4). The use of this base provides a definite and automatic means of orientation plus the added advantage of eliminating any need for the series film cut-out socket adapter. After the initial orientation of the hood so that the lamp is faced in the correct position there is only one possibility of misalignment which is 180° opposite to the correct position. However, this is readily notice-

Figure 3. Picture of trial installation in Salem, Mass., lighted by 2500-lumen PAR street lamps 25 foot mounting, spaced 180'. Figures are measured footcandle values.

able to even inexperienced lamp men. The lamp is marked by means of a knob to indicate the street side, allowing easy identification for correct positioning when replacing lamps.

This base, of course, is not applicable to multiple circuits since normally a medium screw base socket is used for lamps up to and including the 2500-lumen size. Again a screw base does not offer an automatic means of orientation for the asymmetric distribution. Therefore, it is proposed to utilize a base similar to the series base except that the prongs in this case would be shaped to fit into a standard twist-lock receptacle (See Fig. 5).

The receptacle needed is commercially available at a low cost. The use of this combination offers a method whereby the multiple lamp is automatically aligned once the initial orientation is made. The prongs in this case would be "polarized" and there is only one way the lamp can be inserted. Once it is inserted and locked into place its position is maintained. Final details and field tests have as yet not been completed. Therefore, availability of this lamp will be delayed pending results of the tests.

In the symmetric lamp now under development there is no orientation problem involved. Therefore, the standard screw base will probably be used for these lamps.

Although termed a 1000 (or 2500) lumen lamp the ratings are actually based on the filament used rather than the output of the lamp. Therefore the actual output is determined by the efficiency of the glassware (approximately 75 per cent) times the nominal rating. This is consistent with present practice of signing contracts specifying nominal lumen ratings of the lamps to be used rather than the output of the fixture or the amount of light delivered to the street. Although this practice is not exactly conducive to improvements in street lighting, it nevertheless must be considered. By rating the PAR street lamp as 1000 or 2500 lumens nominal, the same voltage and current ratings can be used as for standard lamps, thus allowing equal replacement without circuit adjustments.

Because of the inherently higher cost of this type of lamp which successfully does the job of the lamp reflector, refractor, and film cut-out adapter, lamp life was designed on a group replacement basis. The laboratory lamp life is approximately 3000 hours, which means that service life will be in excess of 2000 hours.

The filament designs chosen were necessarily based on such practical considerations as ruggedness, life, efficiency, and physical size. For the multiple lamps and the 1000-lumen series lamp it was found that a V-shape coil filament is the most

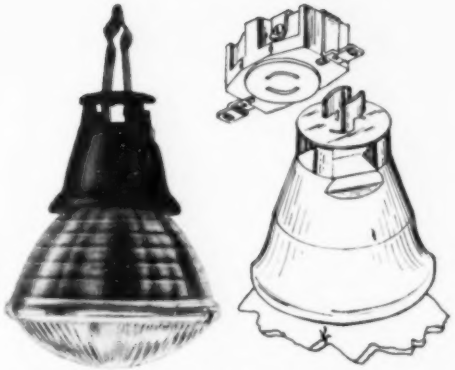


Figure 4. Picture of PAR-38 street lamp mounted with series film cut-out prong base.

Figure 5. Proposed multiple twist-lock base for PAR street lamp and commercially available twist-lock receptacle.

suitable. For the 2500 lumen series lamp a straight, vertical coil-coil filament was found to be the smallest practical source in this size. It is possible that modifications of the filament structure will evolve since the desired goal for a closely integrated reflector-refractor system of such small dimensions is, of course, a point source of light.

This new street lighting lamp is readily adaptable to either new or existing systems. The unit is light in weight (approximately 18 ozs.) and therefore a minimum size mast arm or other physical support is needed. In fact, it is hoped that designers of street lighting hoods and accessories will give this matter real consideration, since it offers excellent possibilities to develop systems with much lighter equipment than presently used. However, no changes are necessary to use this lamp in existing systems except for removal of reflectors where they would obstruct the light output of the lamp. Fig. 6 shows the lamp mounted in the common porcelain hood and also in one of the newer metal hoods.

Cost comparisons show that this new type of street lighting unit is economical to operate,—often more economical than old-fashioned systems such as the radial wave units or the comparable newer type units. The lamp cost itself is, of course, higher than a corresponding lumen output clear glass lamp. However, the savings which can be made in equipment amortization charges and maintenance costs far outweigh this difference, and thus provide better street lighting at an even more economical rate.

The PAR type of unit needs only a light arm, the

Figure 6. PAR-38 street lamp mounted in two different hoods for street lighting.

head, and the lamp. Reflectors are eliminated, and with them their maintenance expense. Operating men have told of cleaning costs ranging from 35 to 90 cents per reflector (provided the cleaning is done at the time of lamp replacement). Even at this cost it is very difficult to obtain anything approximating the original efficiency of the unit. Some cities and locations have had particularly difficult experiences along these lines.[1]

Generally, it has been found that even good cleaning and maintenance cannot bring the unit back to its original efficiency. The effects of corrosive atmospheres are quite severe on some types of reflecting surfaces and the pitting brought about by these conditions can never be eliminated. Recently, it is true, there has been a tendency towards coating the reflecting surfaces and in this way trying to protect them. The PAR type unit not only has its reflector protected from the atmosphere, but offers a brand new reflector each time the lamp is replaced.

The item of breakage, which usually amounts to about 10 per cent, is greatly reduced with the PAR type of unit. Tests have shown that, at ordinary mounting heights (20 feet or more), it is very difficult to break one of these lamps, even with an air rifle.

The development of the PAR street lighting lamp makes it possible to obtain, in the lower lumen categories (1) greater utilization of the generated lumens, (2) higher maintained light output, (3) low cost of operation, (4) easy extension of street lighting into new areas, and (5) simple and effective means of modernizing outmoded systems.

Thus, we believe that this adaptation of the reflector lamp will be a valuable tool for the street lighting engineer, aiding him in his efforts to improve and maintain street illumination.

[1]Francis T. Tillemans, *Maintenance of Outdoor Lighting Equipment*, ILLUMINATING ENGINEERING, Vol. XLIII, No. 4, p. 377 (April, 1948).

DISCUSSION

STUART R. WILLIAMS:* This is a most interesting development. The authors have made some statements which are significant. The discussion on these could involve a rather extended analysis of what constitutes street lighting of the quality sometimes called "good." A bibliography might have mentioned the paper by L. J. Schrenk presented a few years ago before the Illuminating Engineering Society (ILLUMINATING ENGINEERING, Vol. XXXVI, No. 10, December, 1941, p. 1219 to 1245). This paper described a residential type luminaire developed in Detroit. This optical assembly utilized a 55° cut off reflector and a degree of elevation of the light toward either house or street side as required. The idea is not exactly new.

But to return to one or two of the many possible specific points of some question—I would ask the authors to refer to "the item of breakage." On what basis of study is it "usually 10 per cent"? On lamps? There are enclosures for lamps that show much less. Even a PAR lamp used for street lighting does have some possibilities of breakage. If, as the authors state, it is "eliminated," Utopia is surely here.

On their item "greater utilization of the generated lumens." Greater than what? And for how long? It is unfortunate that utilization figures are not available in the paper.

And let us not forget that utilization in street lighting is but a single part of our necessary studies. Distribution is important, too. The problem of a distribution acceptable for street lighting, in any lumen category, is not disposed of by an appraisal only of the more obvious developments of lateral shift and vertical concentration.

CHARLES H. REX:** Messrs. Zack and Benson have given us a very interesting presentation of some well known possibilities in street and highway lighting.

In considering a proposal such as this, we must remember that the primary and basic objective in street lighting is maximum public benefit at minimum cost. Municipal and utility officials have adhered to this objective in the planning, installation, maintenance and operation of street lighting systems. They can well be proud of the saving in life and property, the convenience in travel to and from home, and the comfortable night seeing conditions which have resulted from the proper use of modern street lighting equipment.

As the benefit which the people receive from their investment in street lighting is increased, the cost per unit of benefit is decreased. This improves public relations, builds up prestige and goodwill for all concerned.

These gains, based on engineering experience and knowledge of public opinion, should be developed still further in the future. We must be sure that every new installation, and that each instance in which existing systems are modernized, represents an improvement which will merit the confidence and enthusiasm of people.

One of the principal factors in such progress is the at-

*Holophane Company, Inc., Newark, Ohio.
**General Electric Co., Lynn, Mass.

tention which has been devoted to glare. Glare detracts from the seeing value of the street lighting investment and must be kept at a minimum if we expect to build up public acceptance and use.

Small, highly concentrated high brightness light sources in the field of view cause discomfort and may be a distracting annoyance. This is minimized in modern luminaires and reflectors by appropriate control of the candle power distribution and by providing source areas which are sufficiently large to keep the intrinsic brightness within acceptable limits. A typical enclosed reflector for use with 2500-lumen lamps provides a maximum of 1100 candlepower. At the vertical angle of maximum candlepower, the projected source area is 20 square inches. The refractor globe is 8 inches in diameter. If either the candlepower is increased or the source area decreased, the discomfort with which the reflector may be viewed is increased.

We believe that the people want lighting which is pleasant and comfortable and we therefore hope that Mr. Zack will find it practical to increase the size of the light source, particularly in the 2500-lumen lamp size.

Luminaire reflector systems giving as much as 3000 candlepower from a 2500-lumen lamp could easily be made available but they are not wanted because of glare and because it is generally better to redirect this excess candlepower down to the road at angles lower than the maximum cone for good roadway coverage.

The size of the lamp bulb and the design of the reflector have considerable bearing on the seeing benefit obtained from a street lighting system. These items constitute only a small part of the total cost of the system. Consequently reflectors are chosen on the basis of performance in terms of comfortable seeing provided for the public and low annual cost of maintenance and operation.

Even under adverse conditions, the life of modern reflectors is measured in terms of several years rather than the number of hours that a lamp filament will burn. The types for use with 1000 to 2500 lumen lamps range in price from about $4.00 to $10.00 depending upon whether open or enclosed. The standard lamp bulbs, also produced by high volume production methods, are inexpensive, and are available with various life ratings up to 3000 hours. The rugged lamp filament construction is based on many years' experience in obtaining efficiency and long life. No limitations have been imposed on the size of filament in order to adapt it to a small reflector assembly.

The weight of modern street lighting equipment is nominal considering the requirements for safety, circuit protection and windage. An open reflector for use with 2500-lumen lamps weighs about one pound. The comparable enclosed reflector weighs 3¾ pounds. A modern die cast hood for use with these reflectors on multiple circuits weighs 2½ pounds. Modern open type reflectors are well protected by special processing of the reflector surface. Enclosed reflectors are designed and usually installed with particular attention to maintenance of high luminaire efficiency. During the past twelve years, this has been advanced to the point of a spun sealed joint between the reflector and the enclosing glassware. Modern design has helped minimize chances of depreciation of reflector efficiency.

The annual cost of operation and maintenance is important. Also all other factors such as comfort, glare, distribution, visibility, etc., are equal. Cost comparisons on this basis will indicate the answer. In new installations there is a trend toward the lighting of residential streets by means of large 6000-lumen lamps in shielding luminaires spaced 200 to 300 feet apart. This provides good lighting with economy of installation, operation, and maintenance.

R. M. Hoot:* About a year ago, we made a test installation with four of the controlled beam lamps on one section of a cross intersection, and with open reflectors from three different manufacturers, using a PS 25 2500-lumen lamp, on the remaining three sections. The mounting height was 23 feet with an average spacing between lamps of 107 feet. The controlled beam lamps were mounted in side entrance metal hoods suspended from a 4-foot upsweep bracket. The daytime appearance of this installation was rated as No. 1, but due to the light distribution on the road surface being highly striated, it was rated No. 4 at night.

Whenever a concentration of light flux is emitted from a comparatively small area, high surface brightness results. This is particularly true of this lamp. However, due to the quality of light delivered to the road surface which had a fairly high reflectance, it was believed that the glare factor was reduced considerably. We have been thinking of a lamp of this character in sizes of 6000 and 10,000 lumens, but due to the present manufacturing limitations, we have been told that such a lamp was not possible for some years.

We believe that the controlled beam lamp does have application in rural areas, particularly where either the remote location or atmospheric conditions present a maintenance problem.

Albert Zack and Earle D. Benson:** The authors may be pardoned if they do not agree with Mr. Williams' contention that the PAR lamp is now new. It is granted that many street lighting systems have been designed to meet certain standards of cut-off, elevation and distribution. In fact, the PAR lamp is definitely intended to meet the Type II distribution as established in the I.E.S. Recommended Practice of Street Lighting. However, the concept of an integral lamp and reflector with cut-out base has not been presented to the public before, as far as is known by the authors. On another point we appreciate Mr. Williams' correction. Lamp breakage is obviously not completely eliminated, for it would take much more than hard glass to withstand determined vandalism efforts. The text has been tempered accordingly with thanks to Mr. Williams for bringing this to our attention.

The figure of 10 per cent breakage was obtained from a survey of utilities and it is believed to be representative. It includes breakage due to vandalism, losses due to moisture touching exposed soft glass lamps and breakage due to handling of lamps. It is an average figure including all types of luminaires.

Experience with this lamp, obviously limited, certainly indicates the permanent nature of its light output as compared with lamp and fixture combination which exposes many surfaces to dirt collection and deteriorating effects of atmosphere. With the PAR lamp there is only one surface that can collect dirt as far as light output is concerned and this is pointed downward, making it very difficult for dirt to adhere.

*Philadelphia Electric Co., Philadelphia, Pa.
**Authors.

Lighting for Woolen and Worsted Textile Mills

Prepared by the Joint I.E.S.-A.S.M.E. Committee on Lighting in the Textile Industry

PREFACE

The growth in knowledge of the benefits of properly applied lighting together with the recent important development in electric lamps and other "tools" of illumination, make possible an outstanding service to the seeing problems of industrial workers.

As part of its program to offer better solutions for all types of seeing problems, the Illuminating Engineering Society has formed a number of investigating committees. Each of these groups surveys the particular seeing tasks in the industry under study in order to recommend the quantity and quality of the lighting required for every important operation. The work of each committee is then summarized and published for use by lighting engineers and those who plan the work in industry.

Each committee includes not only lighting specialists but also men from the industry under study. The work of all of these committees is coordinated and reviewed by a Committee on Lighting Study Projects in Industry.

The method of investigation will vary according to needs and according to available technical personnel, time, and funds. In some cases the procedure will include a study and survey of seeing tasks and of lighting practice in large and small plants; to this may be added experimental installations providing several quantities of light and qualities of lighting which will be tried and appraised. Where practicable the foregoing will be supplemented by detailed studies of visibility and brightness patterns on location or in laboratory rooms. Much weight is given to practical considerations provided by the "user" representatives.

Not all of the above procedures are possible in all cases. Effort is being made continually to encourage thorough and scientific investigation and to provide better fundamental criteria. It is the intent that reports of these investigations shall clearly describe the scope and methods of study employed and which underlie the recommendations of quantities of light and of qualities and methods of lighting.

Herewith is presented a report of investigation of "Lighting for Woolen and Worsted Textile Mills."

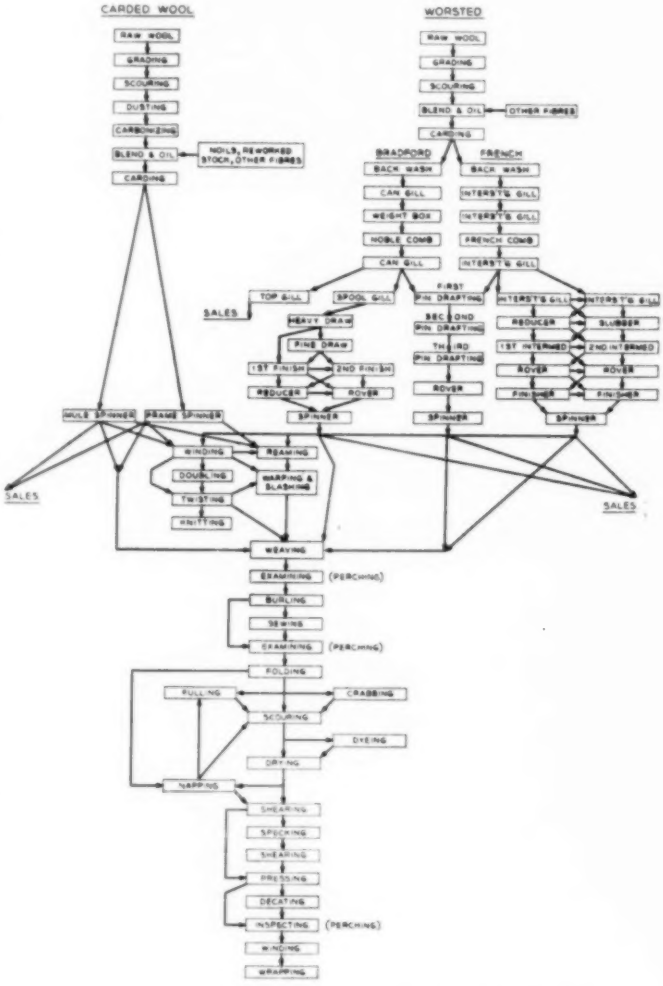


Figure 1. Flow chart for woolen and worsted cloth manufacture.

Figure 2. Wool is sorted out by an expert sorter, skilled in hand and eye, to divide the fleece into many grades according to its length, strength, and degree of fineness.—Courtesy of *Industrial Bulletin*, New York State Department of Labor.

Committee on Lighting Study Projects in Industry

J. R. Chambers
C. E. Egeler
A. W. Larson
Paul Manchester
H. L. Miller
G. G. Rae
M. N. Waterman, *Chairman*

FOREWORD

The Woolen and Worsted Textile Section of the Joint I.E.S. - A.S.M.E. Subcommittee on Textile Mill Lighting has been conducting studies to determine the quantity of illumination and the type of system and its arrangement most desirable and practical for woolen and worsted operations.

Surveys have been made in 17 New England woolen and worsted mills so that a cross-section of problems, operating methods, data and opinion could be obtained on which to base conclusions. The Bachmann-Uxbridge Worsted Corporation Mills, located in various parts of New England and in the South, have served as a laboratory for the activities of this committee. Many types and arrangements of lighting have been compared in these mills and the opinions of textile workers, management, and lighting engineers carefully noted. These data have been correlated with considerations of flexibility, installation, maintenance, and production records in determining the recommendations for woolen and worsted textile lighting as contained in this report.

The activities of this committee are still continuing and will do so until detailed illustrations of lighting practices for all important operations of this industry have been submitted in the form of data sheets. Data sheets have already been prepared on such operations as carding, spinning, weaving and perching. Later additional data will be submitted in similar useful form.

Control, restriction, or scarcity of materials in the years 1942 to 1946 prevented much needed improvement in textile lighting. Today with textile requirements at or close to an all-time peak, and with raw materials and labor at costly levels, modern well-planned lighting is essential to the maintenance of profitable textile operating standards.

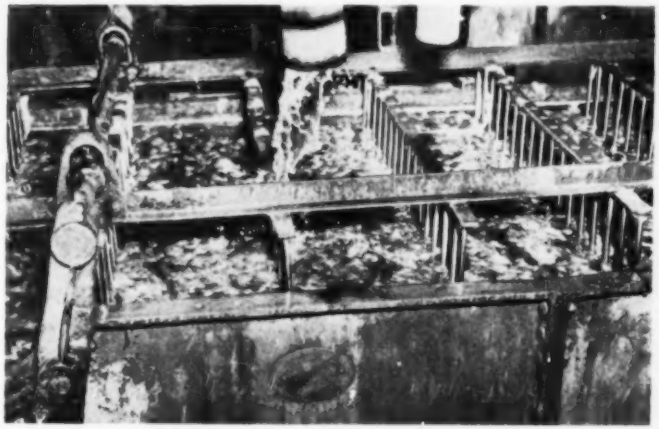


Figure 3. A wool scouring machine which washes the raw stock in a solution of soap and soda.

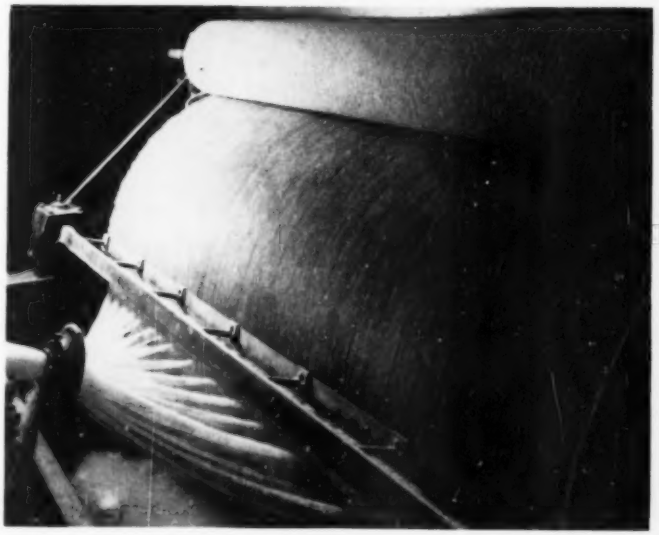


Figure 4. Blended wool fibres are carded to remove snarls and obtain a smooth, even blanket of yarn. The yarn is then twisted into roving in this worsted mill.—Courtesy of *Textile World*.

The committee realizes that operating gains from good lighting involve far more than merely increasing the level of illumination and properly locating equipment. Employee reaction to various lighting methods often modifies the best laid plans of the lighting engineer and this factor has received appreciable consideration in the recommendations of this report. For instance, the type and color of lamps, the type and size of lighting unit, as well as its location and mounting were often influenced by employee desires as long as satisfaction of such desires was possible without unreasonable sacrifice of lighting quality.

Joint I.E.S.-A.S.M.E. Subcommittee on Lighting for Woolen and Worsted Textile Mills

Walter L. Kelley, *Chairman*
Walter P. Rayner
James M. Shute
Fred J. Vorlander
J. Edwin Watkins
Carl E. Rydman, Chairman, A.S.M.E. Lighting Committee

1. Scope and Purpose

This report comprises a series of recommendations for the lighting of woolen and worsted textile mill operations. The illumination levels based upon surveys and accumulated mill experience are presented for the various processes together with a detailed treatment of the lighting design for typical operations most frequently encountered as serious problems.

2. Definitions and Flow Diagram

For the purpose of this report the following definitions are used to clarify the processes through which woolen material must pass to become finished products. Fig. 1 illustrates the flow diagram.

2.1—Cloth Production

(a) *Opening*—Receiving and opening of bales of raw stock.

(b) Grading—Separating the raw stock according to grade. (See Fig. 2.)

(c) *Scouring*—Cleansing the raw wool of natural oils and other impurities. (See Fig. 3.)

(d) *Drying*—Removal of moisture.

(e) *Blending*—Mixing of raw materials by means of blowers or manual operation into a predetermined blend.

(f) *Picking*—Passage of the blended raw materials through picking ma-

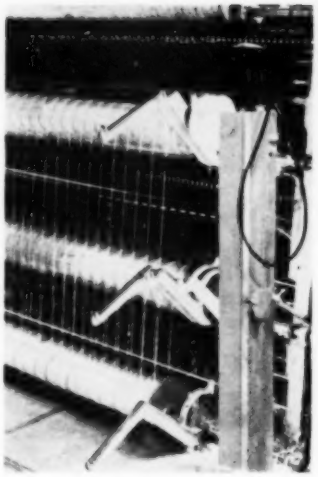


Figure 6. Supplementary lighting is necessary at the delivery end of woolen cards where the roping comes from the machine to the roping spools. The single 30-watt fluorescent lamp unit used here is supported in a vertical position and mounted on a portable base to provide flexibility.

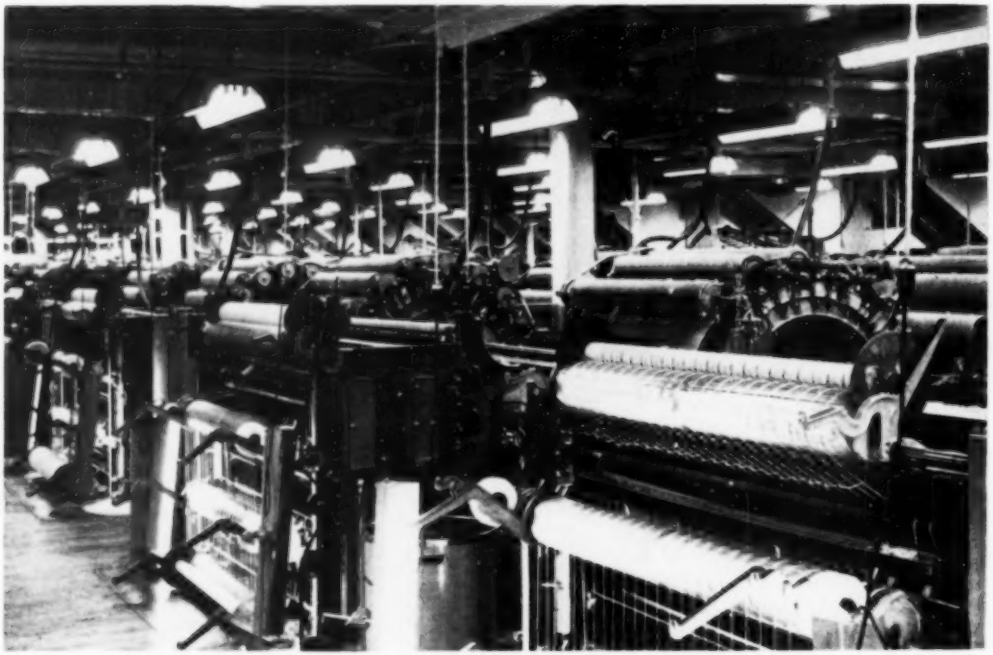


Figure 5. View of general lighting installation in card room. The 60-inch twin lamp fluorescent lighting reflectors produce an average of 45 footcandles on the horizontal surfaces of the machine and 35 footcandles on the vertical side surfaces.

chines to break up and further blend component stock.

(g) *Carding*—Passage of the blended materials through the carding machines for final blending and aligning of fibres. Material is delivered as either roving (worsted) or roping (woolen). (See Figs. 4, 5, and 6.)

(h) *Gilling* (worsted only)—Fibre combing, blending, and drawing by means of closely ranged steel pins dividing the wool fibres into parallel filaments.

(i) *Combing* (worsted only)—Fibres of carded wool fleece are aligned and the short and snarled fibres (noils) removed. Delivered as worsted top. (See Fig. 7.)

(j) *Recombing* (worsted only)—Repetition of combing operation.

(k) *Drawing* (worsted only)—First twisting and elongation of combed tops preparatory to spinning.

(l) *Spinning*—Final twisting and elongation of roving or roping to produce thread. (See Figs. 8, 9, 10, 11, and 12.)

(m) *Twisting*—The combining of two or more treads by twisting and elongation into multiple ply yarn.

(n) *Winding*—Repacking of yarn on spools, combs, bobbins, etc., preparatory to warping or weaving.

(o) *Warping*—Transferring of packaged warped yarn to loom beams.

(p) *Weaving*—Manufacturing of cloth from yarns. Accomplished on looms. (See Figs. 13, 14, and 15.)

2.2—Grey Goods Room

(a) *Burling*—Removal of knots, slubs, and foreign matter from woven fabric.

(b) *Sewing*—Repair of broken ends or imperfections. Replacement of broken or missing threads.

(c) *Folding*—The combining of pieces or cuts of cloth folded out in groups for finishing.

2.3—Wet Finishing

(a) *Fulling*—Treating of unfinished cloth with soap and alkali under weights and pressure to break and open up fabric to further interlock the fibres.

(b) *Scouring*—Washing of grey or fulled fabric to remove soap, alkali, dirt, and impurities.

(c) *Crabbing*—Preshrinking of cloth composed of wool and cotton.

(d) *Drying*—Removal of moisture.

(e) *Decating*—Process of setting the cloth by means of steaming in the finishing process.

2.4—Dry Finishing

(a) *Napping*—Raising of surface fibres for special finishes.

(b) *Shearing*—Cutting nap fibres to obtain uniform length (surface). (See Fig. 16.)

(c) *Conditioning*—Bringing fabric to predetermined moisture content.

(d) *Pressing*—Smoothing and making uniform the surface of cloth by the application of heat and pressure.

(e) *Inspecting* (perching)—Final inspection to determine imperfections. (See Fig 17.)

(f) *Folding*—Final packaging of cloth.

TABLE I

Lighting Levels at the Work—Current Recommended Practice

Process	*Footcandles Maintained in Service*		*Preferred Arrangement of Lighting Units*
	General Lighting	*Specific Lighting (General plus Local)*	
Opening	15		
Grading	25	100	Over tables.
Blending	15		
Picking	15		
Carding	35	Add an internal unit	
Combing	35		
Recombing	35		
Gilling	35		
Drawing (white)	25		Mount units parallel to frame. Minimum height 8′.
Drawing (Colored)	50		″
Spinning (Frame) (white)	25		″
″ ″ (colored)	50		″
Spinning (Mule) (white)	20		Mount units either way. Minimum height 8′.
″ ″ (colored)	40		″
Twisting (white)	25		Mount units parallel to frame.
″ (colored)	50		″
Winding (white)	20		″
″ (colored)	40		″
Warping (white)	20	75 at reed	
″ (colored)	40	″ ″ ″	
Weaving (white)	40		Mount units perpendicular to alley.
″ (colored)	80		″
Grey Goods Room			
Burling	40	75	
Sewing	40	150	
Folding	40		
Wet Finishing			
Fulling	25		Units mounted to direct light into kettle.
Scouring	25		″
Crabbing	25		
Drying	25		
Dyeing	25	50	Vapor-tight lighting units in kettle.
Dry Finishing			
Napping	40		
Shearing	40	75	
Conditioning	40		
Pressing	40		
Inspecting (Perching)	40	300	A 4′ x 4′ bank of fluorescent lighting units.
Folding	40		

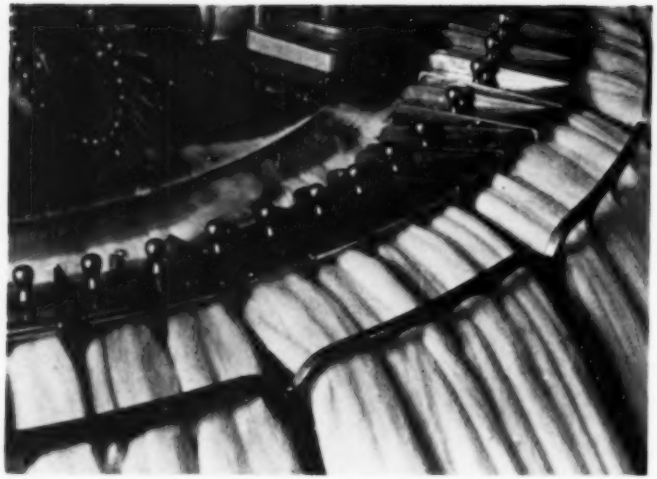


Figure 7. After carding the worsted roving is combed to remove short and snarled fibres. —Courtesy of *Industrial Bulletin*, New York State Department of Labor.

3. Illumination Recommendations

3.1—Quantity of Illumination

(a) The lighting levels in Table I are practicable values based on the visual requirements of the processes or operations involved. Higher levels may be helpful, especially in the case of dark materials and where fine detail is to be seen.

(b) The levels of illumination in Table I should be maintained in service on the work. In locations where the plane of the seeing task is not definite, the illumination is usually measured in a horizontal plane 30 inches above the floor. To assure a maintained level of lighting the initial value in footcandles must be greater by a percentage sufficient to compensate for the depreciation expected.

(c) In most cases general lighting will suffice, especially when the luminaires are positioned in accordance with the wooden machinery layout. Some operations require additional localized illumination. The illumination requirements from the general lighting, the general plus local, and the preferred arrangement of linear light source equipment are shown in Table I. Where positioning is indicated, the use of linear light sources is desirable to assure diffusion and to preserve good visibility through the reduction of shadows.

3.2—Environment — Pleasant, colorful surroundings make workers, especially women, more cheerful and contented, while color used in accordance with the principles of visual perception is a valuable contribution in seeing the task. General recommendations[4] are made as follows:

(a) Colors for general use should be fairly light and are best applied in plain over-all fashion.

(b) Pleasant colors should always be selected and where definite hues, such as green or blue are desired very light greyed tones should be used.

(c) Large areas of strong colors, such as bright red, yellow or green, should be avoided.

(d) While the ceiling should be near white so that the maximum light will be reflected, walls should not be white, as they then become brighter than the work task, and consequently uncomfortable. Reflectances of 50 to 60 per cent are recommended.

(e) Machines should be fairly light in color to reflect more light and to reduce strong contrasts for ease of vision. Reflectances of 25 to 50 per cent are recommended.

(f) Backgrounds to work tasks should be of a carefully chosen color and brightness to contrast with the task.

(g) Contrast obtained by hues of somewhat similar brightness is more efficient and restful than contrast in brightness alone.

(h) The upper surfaces of lighting units should be painted the same color as the ceiling to relieve contrast with ceiling and make them less conspicuous.

4. Lighting Design for Specific Processes

4.1—General Design

4.1.1 — *Introduction* — Previous studies[1,2,3,4] have indicated the desirability of reducing shadows and

Figure 8. The bobbin carrier or jack of the spinning mule moves to and from the stationary frame which supports the spools of roving or roping. When the bobbin carrier is at its most distant spot from the frame, all threads must be visible to the operator who moves about the machines repairing broken threads.—Courtesy of Crompton Parkinson Ltd., Manchester, England.

diffusing light into the many parts of the machinery in order to enhance the visibility of the details of the processes. The practical and economical availability of linear light sources has contributed greatly to the accomplishment of the objective. Fluorescent lighting is now readily adaptable to many of the lighting requirements of the woolen and worsted industry. Electric filament or mercury vapor lighting is useful in many locations where the diffusion of a linear source is not required.

4.1.2 — *Mounting Height* — Where fluorescent general lighting is employed, the units using 40-watt lamps should be mounted not less than 8 feet above the floor. General fluorescent lighting units using 85-watt fluorescent lamps should be mounted not less than 11 feet above the floor. The desired lighting level is governed by the spacing. Mounting heights compatible with suitable uniformity of illumination are recommended for concentrated light sources.

4.1.3—*Shielding*—To reduce the light toward the eye of the worker (glare), the mounting height specified above should be provided, and as much shielding as possible in harmony with efficient light output is recommended. This is especially true for concentrated light sources or where large expanses of linear light sources are exposed.

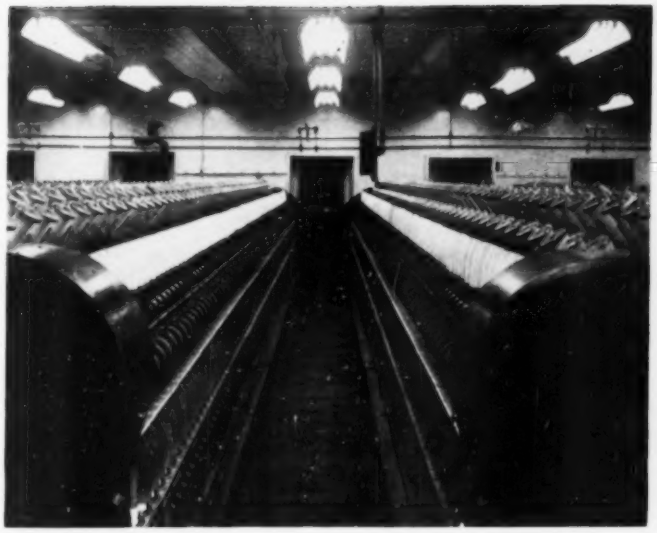


Figure 10. Ring spinners are illuminated in this plant by 85-watt 3500° fluorescent lamps in twin lamp reflectors. The maintained lighting level 30 inches above the floor is 50 footcandles.

4.2—Opening and Grading—When the raw wool arrives at the mill, it must be separated according to grade. This includes careful consideration of length, strength, degree of fineness, and color. (See Fig. 2.) In the room where this operation occurs tables or benches are usually placed near the walls leaving the center free for the bales of wool and baskets. The illumination over these tables should be constant in color and approximate average daylight conditions. To fulfill this fluorescent lighting of 6500°K is recommended. General illumination will suffice for other areas in the room.

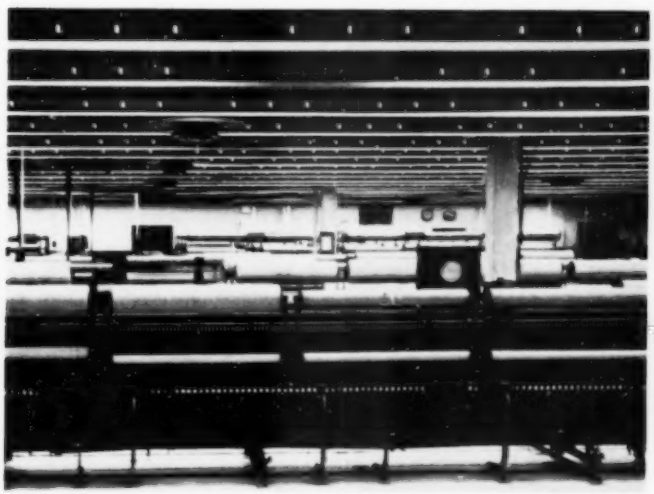


Figure 9. Continuous rows of 48-inch single lamp reflectors equipped with 40-watt 3500° white fluorescent lamps provide a 35 footcandle illumination level at these mule spinners.

4.3—Carding

(a) In this operation the woolen or worsted fibres delivered to the cards from preparatory processing are further blended and the fibres aligned. The operator keeps the laps of fibres feeding unbroken through rollers equipped with continuous wire combs as shown in Fig. 4. For this operation, general lighting of 35 footcandles is recommended as minimum. This same lighting equipment when properly located provides sufficient illumination for the card fixer who requires light at the sides of the machines for cleaning, adjusting, and repairing the machines.

(b) Fig. 5 illustrates a general lighting installation of twin lamp fluorescent lighting reflectors which produces an average of 45 footcandles on the horizontal surfaces of the machine and 35 footcandles on the vertical side surfaces. This installation consists of 60-inch reflectors spaced on 9-foot x 11-foot centers and mounted 11 feet 6 inches above the floor. Each

unit is equipped with two 85-watt 3500° white fluorescent lamps. The luminaires are mounted at 90 degrees to the axis of the aisles beside the cards.

(c) On woolen cards, a difficult seeing problem exists at the rub apron at the take-off end of the cards where the roping comes from the machine to the roping spools. General lighting will not satisfactorily produce adequate illumination for this task. It has been found that 45 to 75 footcandles of localized lighting so applied as to eliminate serious shadows will provide good working conditions. Fig. 6 illustrates a method satisfactorily employed to produce such an effect. The unit shown is equipped with one 30-watt fluorescent lamp. The lamp is supported in a vertical position and mounted on a portable base to provide flexibility. These vertical supplementary floor stand units are required for the purpose of horizontally distributing increased illumination at the delivery end of the rub apron. Such supplementary lighting is not considered necessary for worsted cards.

4.4—Spinning

4.4.1—*Spinning Mules*

(a) This operation involves the final twisting and elongation of roving or roping to produce thread as shown in Fig. 8. The bobbin carrier or jack moves to and from the stationary frame which supports the spools of roving or roping. When the bobbin carrier is at its most distant spot from the frame, all threads must be visible to the operator who moves about the machines repairing broken threads. The working plane is 36 inches high at the threads and up to 42 inches at the back rolls.

(b) General lighting is the best solution to this lighting problem. Illumination requirements depend upon the color of the material involved. As shown in Table I, these values range from 20 footcandles for white material to 40 footcandles for colored materials.

(c) Fig. 9 illustrates a typical installation of continuous rows of single lamp reflectors. The rows are on 6-foot 6-inch centers and mounted 10 feet 6 inches above the floor. Each 48-inch reflector section is equipped with one 40-watt 3500° white fluorescent lamp. This installation produces 45 footcandles initially and has a maintained value of 35 footcandles when cleaned of lint once each week. When single lamp units are installed, adjacent lamps should be equipped with twin lamp high power factor ballasts in order to minimize the stroboscopic effect. When twin lamp reflectors are used, the luminaire spacing shown in Fig. 9 should be modified. In general, to provide 25 footcandles average maintained illumination, one twin lamp 48-inch industrial reflector with 3500° white lamps should be provided for each 70 square feet of area involved. It appears to make little difference whether the rows of lamps run parallel to the mule frame or at 90 degrees to the frame.

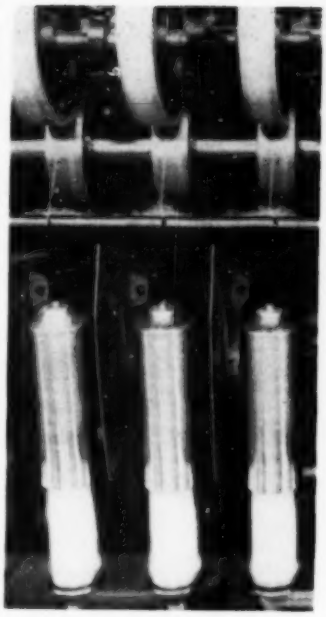


Figure 12. Closeup showing how the lighting installation shown in Fig. 11 eliminates shadows of the spindle barriers on the spindles.

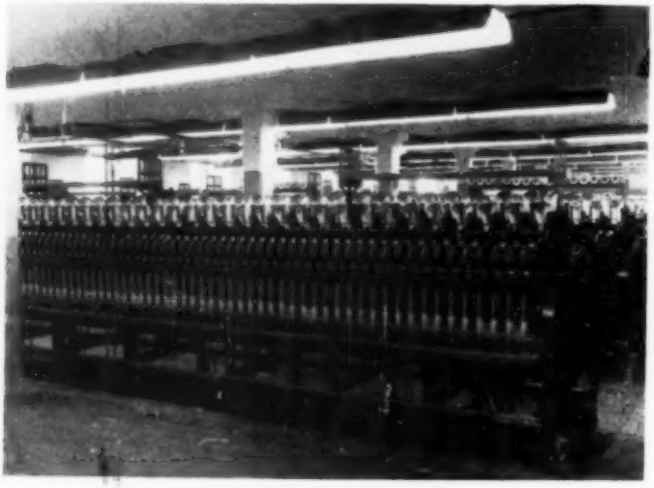


Figure 11. Cap spinners illuminated by open end, twin lamp reflectors mounted in continuous rows on 8-foot centers 8 feet above the floor. This installation provides 60 footcandles at the bar and 50 footcandles at the spindles.

4.4.2—*Spinning Frames*

(a) Spinning frames may be divided into two classifications: ring spinners and cap spinners. Fig. 10 illustrates one solution to the problem of lighting a ring spinner. This installation uses twin lamp reflectors and 85-watt 3500° white fluorescent lamps. These lighting units are mounted 11 feet 9 inches high with their long axis parallel to the aisle and are spaced 9 feet apart in rows 8 feet apart. The maintained lighting level is 50 footcandles on the horizontal plane 30 inches above the floor.

(b) Fig. 11 illustrates the lighting of cap spinners. Open end twin lamp 48-inch reflectors are mounted in continuous rows with the rows spaced on 8-foot centers and mounted 8 feet high. This installation produces 60 footcandles on a horizontal plane at the bar and 50 footcandles at the spindles where the seeing tasks are most impor-

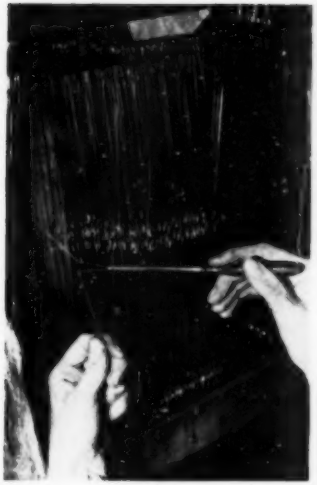


Figure 13. Drawing-in, the first step in weaving. Threads from the warping beam are drawn through the heddles which control, when placed in the loom, the lifting or lowering of the warp threads in order to produce the weave desired.—Courtesy of *Industrial Bulletin*, New York State Department of Labor.

tant. A closeup view, Fig. 12, illustrates how this type of lighting eliminates shadows of the spindle barriers on the spindles, an important factor in lighting these machines.

4.3 — Weaving — This is one of the most critical tasks in textile operation and one where good illumination is most profitable since this is the basic production department of the mill. (See Figs. 13 and 14.) The lighting equipment must be arranged to minimize shadows. This can best be accomplished by installing rows of fluorescent luminaires perpendicular to the axis of the weave alley. Arrangements similar to those shown in Fig. 15 will enable the weaver to inspect the finished cloth as it is woven, detect broken threads, and repair them. They also provide satisfactory quantity and distribution of illumination for inserting the loom beam and for cleaning and maintaining the loom in good working order. Lighting requirements vary depending upon the color of the product; 40 footcandles is an average value for white cloth and 80 footcandles the requirement for colored cloth. In general, it has been found that when lighting levels of 80 footcandles were obtained by the use of

TABLE II

Effect of Lighting on Production Efficiency

Wool Yarn Spinning—1¼ Run
Lighting changed from 11.0 ft-c incandescent to 42 ft-c fluorescent.
Production improved 9.6%—Bad yarn decreased 11.5%.

Wool Yarn Spinning—2½ Run
Lighting changed from 11.0 ft-c incandescent to 42 ft-c fluorescent.
Production improved 8.4%—Bad yarn decreased 12.6%.

Weaving Automobile Cloth Type 1—worsted warp, wool filling

Weaving efficiency	Incandescent lighting,	14-17 ft-c	81.0%
"	" Fluorescent "	32 ft-c	84.0%

Decreased mending cost 22%.

Weaving Automobile Cloth Type 2—worsted warp, wool filling

Weaving efficiency	Incandescent lighting,	14-17 ft-c	83.0%
"	" Fluorescent "	32 ft-c	87.7%

Decreased mending cost 25%.

Weaving Wool Dress Goods—wool warp, wool filling

Weaving efficiency	Fluorescent lighting,	32 ft-c	66.5%
"	" " "	52 ft-c	69.0%

Decreased mending cost 12.5%.

Weaving Wool Filled Cotton Warp Men's Wear

Weaving efficiency	Fluorescent lighting	32 ft-c	78.3%
"	" " "	52 ft-c	81.5%

Decreased mending cost 14.0%.

Weaving Automobile Cloth—worsted warp, wool filling

Weaving efficiency	Fluorescent lighting	52 ft-c	82.4%
"	" " "	70 ft-c	83.8%

Decreased mending cost 9.0%.

Average results from weaving tests show improvements progressively as follows:

Lighting	14-17 ft-c Incandescent	32 ft-c Fluorescent	52 ft-c Fluorescent	70 ft-c Fluorescent
Weaving Efficiency	100%	104.6%	108.7%	110.5%
Mending Costs	100%	76.5%	66.4%	60.4%

Figure 14. In the loom above, the warp is the long threads that move up and down as controlled by the heddles. The filling thread passes back and forth through the warp threads as the shuttle is propelled from side to side.—Courtesy of *Industrial Bulletin*, New York State Department of Labor.

unlouvered, porcelain-enameled, industrial fluorescent lighting reflectors, surface brightness of the fixtures and lamps approach values where a glare condition exists. In view of this, it is recommended that where higher levels of illumination are required for mounting heights of 10 feet or less reflectors should be equipped with shielding in the form of well-designed louvers having a shielding angle of not less than 45 degrees.

4.6—Perching

(a) This operation involves the final examination of finished worsted and woolen textiles. Proper quality and color of light is very important here.

(b) Each perch hangs vertically from the framework and the perch board (often adjustable) is usually set at a 10-degree angle from the vertical toward the inspector. As the cloth is pulled over the board and stacked at the bottom, the ex-

Figure 15. Here, and on facing page are three examples of good lighting practice for looms.

aminer looks for imperfections of all kinds, i.e., wrong colors of yarn, off-shades, spots, shadiness of goods, and mistakes in pattern.

(c) This is a very severe visual task and requires direct illumination ranging from 300 to 400 footcandles of localized lighting plus 40 footcandles of general lighting. This can best be provided by a fluorescent lamp installation of the type shown in Fig. 16. This unit consists of five twin lamp or ten single lamp specular reflectors each equipped with a 40-watt daylight fluorescent lamp. The frame is mounted in a nearly vertical position and at such an angle and height facing the perch board that a line perpendicular to the face of the reflectors, midway between the ends of the tubes, strikes the perch board at the eye level of the examiner who stands facing the perch board with the light at his back. (See Fig. 16.)

(d) The framework of the perch should be of a neutral, light shade to minimize brightness ratios. Any existing windows in back of the examiner should be covered with an opaque paint to block out daylight so that variation of daylight intensity and color will not create interference. The daylight colors of lamps are chosen because most workers prefer this color at the high intensities used here. Due to the use of specular reflectors the apparent brightness of the assembly is low.

5. Results of Improving Textile Illumination

(a) Actual tests to prove the tangible advantages of improving the illumination of textile operations are very limited due to the many variables which are a basic part of the textile industry. Types of stock or types and styles of fabrics going through any one department change frequently in the modern woolen or worsted mill. Rarely are these factors constant sufficiently long for various qualities or quantities of illumination to be com-

(Continued on page 21A with references and Fig. 17)

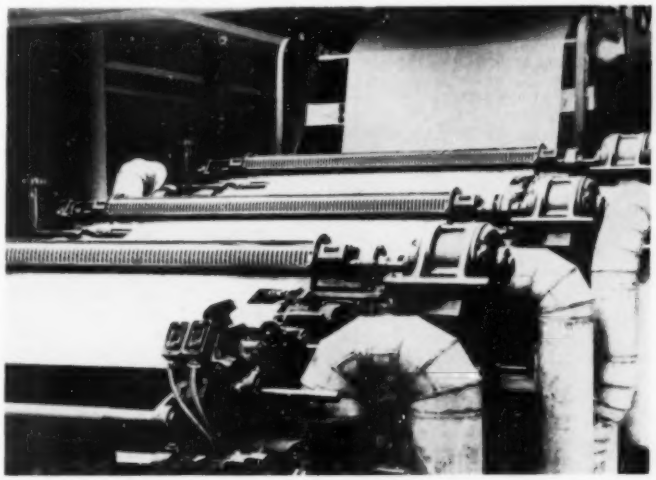


Figure 16. The final process on wool cloth is shearing, in which a fine, even finish is produced by shears which operate like hair clippers or a lawn-mower.

TELECAST

LIGHTING NEWS OF CURRENT INTEREST

Take Your Choice at French Lick Conference
Wide Preference Available—September 19-23

With rooms and meeting halls under one roof, of the French Lick Springs Hotel, the stage will be set ideally between September 19 and 23 for members of the lighting profession who want to get their full quota of meat from the National Technical Conference, or those who go for something specific on limited subjects, and spend the rest of their time relaxed in the unique surroundings of this world-famous Hoosier institution.

The schedule of events is not hard and fast at this time, and there may be a few and slight changes, perhaps in order of appearance or time. However, here is a notable series of subjects to be presented by authorities in their respective fields:

Tuesday Afternoon—First Session on Sources

Metal Reflector Coatings for Filament Lamps—D. E. Elmendorf.
Rare Gas—Mercury Discharge—G. Meister and T. Heine.
Short Arc Mercury Lamps——G. A. Freeman.
Humidity Effect on Instant Starting Fluorescent Lamps—T. C. Sargent.
Thermionic Emission in Gas-Filled Incandescent Lamps—Richard Clapp.
Color Preference Studies in Fluorescent Lamps—G. R. Buck, II.

Wednesday Morning—General Session

Application of Recommended Brightness Limitations in School Class Rooms—F C. Winkler and John J. Neidhart.
Specular Reflections in a Drafting Room Using Louver and Luminous Ceilings—B. S. Benson and Eric H. Church.
Brightness in Visual Field at Borderline between Comfort and Discomfort—Dr M. Luckiesh and S. K. Guth.
Utilization Curves for Floodlights—M. E Keck.

Thursday Morning—Street Lighting Session

Photographs Truly Depicting Lighted Streets—R. M. Hoot and J. L. Tupper.
Effective Practice in Lighting Unusually Hazardous and Irregular Roadway Areas—R. M. Sweetland.
Lighting Design for Night Driving—Prof. D. M. Finch.
Low Mounting Fluorescent Sources for Roadway Lighting—R. G. Slauer.
Crest Roadway Lighting for Grand Coulee and Shasta Dams—R. L. Bossard.

Parallel Thursday Morning Session—Residence Lighting—Technical

Laundry Lighting Requirements—A. W. Kakilty.
Lighting for Pianos—E. W. Commery and Mary E. Webber.
Lighting and Color in the Home—Gladys Miller and S. Reynolds.
Lighting for Sewing—Myrtle Fahsbender and Priscilla Presbrey.
Studies of Lighting and Visual Problems of Television in the Home—E. W. Commery.

Thursday Afternoon—Color Symposium

Color Systems—Dr. Deane Judd.
Psychological Factors of Colors in I.E.S. Problems—R. Evans.
Introduction to Color—Prof. Isay Balinkin.

Friday Morning—Second Session on Sources

The Determination of Color Parameters of Fluorescent Lamps—C. W. Jerome.
Fluorescent Circuits for Special Applications—J. H. Campbell.
Low Temperature Performance of Krypton Filled Fluorescent Lamps—George S. Evans.
Performance of Fluorescent Lamps on Various Operating Cycles—F. J. Vorlander.
Fluorescent Lamp Operation at Low Temperatures—S. W. Gray.
Performance Comparison of Hot and Cold Cathode Lamps—Fred W. Reuter.

Friday Afternoon—General Technical Session

Daylight Control at Windows—Prof. R. L. Biesele, Jr.
Time-Saving Photometric Methods and Calculations—G. R. Baumgartner.
Technique of Lighting Generating Stations—H. F. Carroll and W. B. Morton.
One-Hundred Footcandles in a Troffer Lighted Classroom—D. E. Mozes and T. R. Anderson.
Modern Photometry of Fluorescent Luminaires—G. A. Horton.

Entertainment Plans

At this time entertainment plans include a Monte Carlo party on Monday evening, September 19th, to be followed on Tuesday night by a "Hoosier Barn Dance," including barbershop quartet entertainment which may feature a contest among the entries from various Sections and Chapters. The atmosphere will be strictly informal as indicated by plans for a "rube" band as the evening's keynote. Wednesday evening will be devoted to dancing, cards, billiards, bowling, and generally getting better acquainted. The feature of Thursday evening is the President's Reception Banquet and Dance in the usual tradition of such affairs. It will include several acts of professional entertainment which should be outstanding.

Lighting Service Forum

This session is a sure "must" on the Conference schedule. It leads off the week's programs on Monday, September 19th, and promises an unusual opportunity for those attending.

UNDER ONE roof — Delegates at the French Lick Conference, September 19-23, will enjoy the convenience of rooms and meeting halls, all under one roof of the beautiful French Lick Springs Hotel.

CONFERENCE PLANNERS—Some of the many I.E.S. members now at work to plan "The Best Conference Ever" at French Lick, Indiana. Left to right, R. W. Butts, Chairman of the Executive Committee, French Lick Conference; R. F. Hartenstein, Chairman of the National Technical Conference Committee; Lee T. Tayler, President of I.E.S., opening speaker; C. H. Goddard, Vice-President; A. H. Manwaring, General Secretary, active participants in the program.

Present plans, now being completed by Chairman J. M. Stedman, include a practical demonstration of the methods and techniques used by the winners of the planned lighting awards, offered by the Edison Electric Institute and the Better Light-Better Sight Bureau this year. Here you will see demonstrated sound constructive adaptations of lighting design principles and educational methods applied to actual problems arising in the field, and presented in an unusual and original manner.

The Lighting Service Committee assures the Conference planners that their program will be a high point in this year's Technical Conference.

SPORTS PROGRAM

1. Golf Tournament for the President's Cup.

2. Golf Tournament of teams representing the various Sections and Chapters, with a suitable prize for the winning team.

3. Golf Tournament for the women. The tournament is now scheduled for Tuesday afternoon.

4. Trap-shooting contest, with a prize for the contestant breaking the largest number out of twenty-five targets.

5. Bowling competitions for men and women, with a variety of prizes.

6. Archery Contest or exhibition.

7. Ping-pong tournaments for both men and women.

8. Men and women shuffleboard contests, with suitable prizes for each division.

LADIES' PROGRAM

The Sports Committee offers a Sports Tournament for ladies on Tuesday afternoon which will include bowling, golf putting, badminton, ping-pong, tennis, archery, and croquet. Any who prefer strictly mental exercise will have Bingo.

Of course, the ladies will feature largely in the informal "Hoosier Barn Dance" party on Tuesday evening.

Wednesday presents two opportunities to the ladies. They may visit the Lanier Mansion at Madison, Indiana, which is famous for its antiques, or they may join the trip to Spring Mill Inn, located in one of Indiana's most beautiful state parks. A third opportunity, of course, is within the environs of the French Lick Springs Hotel itself, which has so much of a variety to offer that some will not want to leave its charming atmosphere.

A bridge luncheon at the French Lick Country Club will be the feature of Thursday. That evening the President's Reception and Dance will bring out more formal attire, for husbands as well.

As advance registrations stand now, it is very likely that attendance will exceed the original estimate of 1,000. Many members have arranged their vacations to fit the September dates, when summer still lingers around central Indiana.

Regional Conferences Coming Up

The characteristics of the publishing field, which call for published material to go to the printer at least a month ahead of publication, frequently foil the Publications Department of I.E.S. in the coverage of "hot" Society news. Two important Regional Conferences held in May break just too late for the June issue. Full coverage on the Northeastern Regional Conference held May 12-13 in Hartford, Conn., and the Great Lakes Regional Conference held May 23-24 in Rochester, N. Y., will therefore be made in the July issue of the Telecast Section. The final Regional Conference planned for this year will be the East Central Regional Conference, June 2 and 3 at Harrisburg, Pa., which will also be just in time for July ILLUMINATING ENGINEERING.

Illuminating Engineering Reprints

To provide readers as well as authors with quantities of reprints of

ORIENTAL GARDENS at the French Lick Springs Hotel, will be but one of the many beautiful and relaxing spots to be enjoyed by delegates and guests at the 1949 Conference.

articles, it is planned to hold future issues of ILLUMINATING ENGINEERING in type for about four weeks following publication. Orders should be submitted to the Publications Office, Illuminating Engineering Society, 51 Madison Avenue, New York 10, N. Y. As the cost of reprinting varies with the number of pages and the quantity ordered, prices for a specific item will be submitted on request. While many authors follow the practice of getting a small quantity of reprints for their own use, the Publication Office does not in general have sufficient extra copies for possible continued demands.

Southwestern Regional Conference Keeps Pace with New Industrial Growth in Texas

The active post-war industrial development in Texas was reflected by the recent I.E.S. Southwestern Regional Conference, held April 10, 11 and 12 in Houston, Texas. Planned to be of special benefit to lighting people in that area, the technical program and inspection trips planned were particularly successful. Some 165 people from all parts of the Society's largest Region attended the three-day meeting. Represented were I.E.S. members from all parts of Texas, Oklahoma, Colorado, New Mexico, and parts of Louisiana—all of these territories comprising the geographical area of the Southwestern Region.

The South Texas Chapter at Houston, Texas, was host to the conference, which was under the direction of Harry Hrivnatz, lighting engineer for the Houston Lighting & Power Co., as general chairman. Expert committee planning was largely responsible for the successful operation, with bows due also from Sumner Harris, in charge of Publicity; James M. Hartsfield, who handled Attendance problems; E. L. Goddard, in charge of Papers and Program; G. B. Jamison, Entertainment and Ladies' Reception; W. N. Attaway, Hotel arrangements; and W. O. Clark, who managed the conference's financial affairs.

It is evident from the committee structure that the conference organizing was fully on the scale of a national meeting.

In addition to the technical program, the Southwestern Regional Conference also featured a number of interesting side trips and meetings. A joint meeting was held on Monday noon, April 11, with the Houston Engineering Club, at the Ben Milam Hotel. C. M. Cutler, General Electric Co., Cleveland, Ohio, was the guest speaker.

A special tour of the fabulous Shamrock Hotel was also arranged, with the lighting features pointed out by L. I. Eiffert. And in common with other I.E.S. meetings, a popular feature was a dinner-dance, held at the Rice Hotel in Houston.

The conference afforded of opportunity of a special Manager's meeting, attended by the Regional Vice-President, R. L. Biesele, Jr., and the chairmen of the Region's Sections and Chapters. Participating in this were T. C. Lauck, Chairman of the Alamo Chapter; L. M. Bailey, Chairman of the Rocky Mountain Chapter; George B. Jamison, Chairman of South Texas Chapter, H. B. Sudekum, Chairman of the Southwestern Section, and Mr. Biesele.

In keeping with the "convention scale" of the conference's planning, entertainment included a golf tournament, with an informal reception following; teas for visiting ladies, style shows, and sight-seeing through the colorful southwest city.

The technical program, which stressed in particular, industrial application, included:

Sunday, April 10

Manager's Meeting
Golf Tournament
Informal Reception for Out-of-Town Visitors.

Monday, April 11
George B. Jamison, *Chairman*

Address of Welcome — F. M. Austin, Vice-President of Houston Lighting and Power Company.
"This Conference"—R. L. Biesele, Jr., I. E. S. Regional Vice - President, Southwestern Region, and Professor of Electrical Engineering, Southern Methodist University, Dallas.
"Pros and Cons of Lighting Systems" —Don P. Caverly, Sylvania Electric Products Inc., New York, N. Y.
"Store and Office Installations in the Southwest"—W. E. Folsom, Dallas Power & Light Company.
"The Future of Lighting"—C. M. Cutler, General Electric Company, Nela Park, Cleveland, Ohio.

Afternoon Session
H. B. Sudekum, *Chairman*

"Color Conditioning for Industry"—H. R. Wells, E. I. duPont de Nemours Company, Dallas.
"Classroom Planning"—Walter Rolfe, Goleman and Rolfe, Architects, Houston.
"Lighting for the Shamrock Hotel" —L. O. Eiffert, Wyatt C. Hedrick, Architects, Houston.
Dinner Dance — Empire Room, Rice Hotel.

Tuesday, April 12
T. C. Lauck, *Chairman*

"Chemical Process—Plant Lighting"—J. W. Snow, Dow Chemical Corp., Freeport.
"Slimline Applications"—C. M. Cutler, General Electric Co., Nela Park, Cleveland, Ohio.
"Lighting for the Service Station"—Tom M. Rainbolt, Humble Oil & Refining Company, Houston.
Inspection Trips—Downtown Houston Stores; Shamrock Hotel.

SOUTHWESTERN REGIONAL Conference, held in Houston, Texas, April 10-11-12, 1949, featured a well-rounded program including several papers on different phases of industrial lighting. Shown is part of the group of 165 lighting people from the Southwest Region attending the three-day meeting.

Toronto Conference Sets Record for Canadian Region

With delegates in attendance from Nova Scotia to British Columbia, and several visitors from the United States, the Sixth Annual Conference of the Canadian Region set a new attendance record with a formal registration of 133 men and 27 women totaling 160. Some 25 visitors, whose attendance was recorded but who were not registered as delegates, brought the recorded attendance up to 185.

Without being formally stated in so many words, it became quite clear as the meeting progressed that the underlying motivating theme was *better lighting service to the ultimate user*, this to be accomplished through the competently planned application of the results of co-ordinated research and accumulating experience as revealed and exchanged through such meetings as this and through the medium of the Society's publications. In the opening session, President Tayler introduced one phase of this theme in calling for a greater professional consciousness on the part of Society members in all branches of the field, and for the more effective use of available lighting information. Inspector Vernon Page of the Toronto Police, touched upon another phase at the dinner session in pointing out the close relationship between appropriately applied lighting and public safety, particularly traffic safety. Still another phase was embraced in the closing-luncheon-session comments of Past President Ward Harrison, where he not only pointed out some of the fruits to be expected from current research and development during the next ten years, but called upon I.E.S. members to take their proper places in civic affairs both local and national rather than to continue to leave this all-important field as the property of the professional politician.

PROGRAM

Three technical sessions, one Thursday morning, one Thursday afternoon and one Friday morning; two recognized group luncheons, one Thursday and one Friday; comprised the Conference program, topped off with a reception, dinner, and dance for a social evening on Thursday.

The opening technical session was presided over by Chairman H. C. Jones of the Toronto Section, and was comprised of the following features:

1. "Welcome to Delegates," by Bert Merson, Vice Chairman of the Toronto Electric Commissioners.
2. "Opening Remarks" by I.E.S. Regional Vice President Duncan M. Jones of Montreal.
3. "I.E.S. Activities" by President Lee E. Tayler.
4. "Office Lighting" by Robert L. Zahour of the Westinghouse Company, and member of the New York Section.

W. J. Montabone of the Ottawa Chapter substituted for Chapter Chairman D. S. Robertson in acting as Chairman of the Thursday afternoon Technical session, the features of which were:

1. "I.E.S. Recommended Practice of School Lighting, In Practice" by J. M. Chorlton, Engineer, Toronto Board of Education, and member of the I.E.S. Toronto Section.
2. "Seeing Colors" by Ralph Evans of the Eastman Kodak Company, Rochester, N. Y.
3. "Lighting the C.N.E. Grandstand" by F. C. Mayberry, Chief Engineer of the Canadian National Exposition and member of the I.E.S. Toronto Section.

For the Friday technical session, G. F. Mudgett of the Hamilton Chapter substituted for Chairman Walter Bennie of that Chapter as Chairman. The three items on the Session program were:

1. "The Consulting Engineer's Approach to Lighting Projects" by Don Angus, of H. H. Angus Associates, Toronto Consulting Engineers, and member of the Toronto Section.
2. "Supplementary Lighting in Industry" by G. Frank Dean Supervisor of Lighting Service for the Toronto Hydro-Electric System, and member of the Toronto Section.
3. "Development Trends in Fluorescent Lamps" by A. C. Barr of the General Electric Company, Nela Park, Cleveland, Ohio, and member of the Cleveland Section.

Chairman of the Thursday luncheon session was Chairman Joe Thomas of the Montreal Section. Toronto's Mayor H. E. McCallum had been scheduled to speak at this luncheon, but in his place he sent Chairman Loftus Reid of the Toronto Electric Commissioners as his representative to welcome the I.E.S. delegates to Toronto. Guest speaker of the occasion was Inspector Vernon Page of the Toronto Police Department who spoke on the topic "Street Lighting and Traffic Safety." General Chairman Howard L. Wright of Montreal was master of ceremonies at the banquet which featured President and Mrs. Tayler as special honor guests. As guest speaker for the occasion, Regional Vice President Duncan M. Jones spoke of the challenging opportunity for effective public service available to I.E.S. members through the medium of Society activities.

"Some Objectives for 1959" was the title of the address delivered at the closing luncheon session Friday afternoon by I.E.S. Past President Dr. Ward Harrison, recently retired head of the General Electric Company's engineering staff at Nela Park. Chairman for the luncheon session was Vice-President Duncan M. Jones.

COMMITTEE PERSONNEL

Committee Personnel responsible for the success of the Toronto Conference were as follows:

General Chairman: Howard L. Wright of Montreal.

Papers and Programs: J. W. Bateman (Chairman), G. Frank Dean, and John M. Chorlton of Toronto; A. Mendel of Montreal, E. G. Wimperis of Ottawa, G. F. Mudgett of Hamilton.

Hotel: P. G. Kirkpatrick, Chairman, Dave Wilson of Toronto, W. D. McLeish of Montreal, W. T. Partridge of Ottawa, and Jas. E. L. Walker of Hamilton.

Entertainment: D. J. McKenzie (Chairman), N. B. Chadwick, R. C. Allison, Dave Wilson, and Harold R. Whale of Toronto; Robert C. Thomas of Montreal, S. Wright of Ottawa, and Alex Davidson of Hamilton.

Finance: J. Carl Wilson (Chairman), H. F. Davidson, and R. M. Love of Toronto; E. Doug. Leigh of Montreal, W. E. Reny of Ottawa, and G. M. Whittaker of Hamilton.

Publicity: F. C. Ashby (Chairman), N. E. Gerry, and J. W. Hensen of Toronto; A. H. Johnson of Montreal, W. C. Tunnock of Ottawa, and J. P. Mackid of Hamilton.

Transportation: J. E. Landers (Chairman), Ernest W. Green, and Bruce McCaul of Toronto; A. M. Yuile of Montreal, M. J. Cote of Ottawa, and Jas. E. L. Walker of Hamilton.

CANADIAN REGIONAL Conference at the Royal York Hotel, April 28-29, registered delegates from all parts of Canada. Part of the rush for registration was snapped by the photographer from the Canadian publication *Electrical News and Engineering*.

Registration: Douglas Fielding (Chairman), Thomas Dixon and J. Mc Naughton of Toronto; E. E. Morris of Montreal, D. Hayman of Ottawa, and O. H. Boyd of Hamilton.

Office Lighting

In discussing office lighting, Mr. Zahour traced briefly the history of the development of office lighting from the 5 or 10 footcandles of 25 years ago up to the 30 to 50 footcandles which currently constitute good office lighting practice. He outlined the development of the principles and practices such as now put forth in the I.E.S. Recommended Practice of Office Lighting.

As to the economies of a lighting project, Mr. Zahour pointed out that often it is necessary to remind the customer or potential customer that better light means quicker seeing, and that quicker seeing means faster and more accurate work performance. He mentioned also the importance of proper maintenance of lighting installations, and the corresponding necessity of providing proper maintenance information for the users of lighting installations. He urged that it should become standard practice to furnish maintenance information to customers purchasing lighting projects just the same as the purchaser of an automobile or other such equipment receives operating and maintenance information with it.

School Lighting—In Practice

The IES-ASA "Standards for School Lighting"—as they work out in actual practice—were discussed at some length by Mr. Chorlton of the Toronto Board of Education. They work out very well, according to the experiences of the speaker. He pointed out that there are at least four significant differences between school lighting and other lighting applications such as stores and offices:

1. The dimensions of the standard class room are of the order of 24 x 32 x 12 feet, thus presenting an area smaller, generally speaking, than the areas involved in stores and offices. All the elements in the visual field, such as walls, windows, ceilings, accordingly are much closer to the task in the school classroom than they are in industry and commerce.

2. Young eyes in the formative stages are being dealt with; also young minds which find difficulty in concentrating upon a given task. It is necessary therefore to make the seeing task not only easy, but also attractive.

3. The standard classroom has a large expanse of window, in contrast with the average office and store. Further, the window area often is in the line of vision, and thus the control of daylighting becomes a matter of major importance.

4. In the classroom, the line of average vision is more than 50 per cent above the horizontal, since the student is required to view the front chalk board, the teacher, and the various other exhibits at the front of the room. Therefore, rigorous control of all the brightnesses along and above the horizontal line of vision is essential to comfortable visual environment.

Seeing Light and Color

Speaking on the topic "Seeing Light and Color," Mr. Evans discussed the what, why, and how of the phenomenon known technically as the perception of illumination. He described the effect called "color" as being purely a mental effect growing out of the sensations recorded by the eye, an effect beggaring description in words. He stated that of the 500 most frequently used words in the English language, only 15 relate in any way to vision, and of these only five are concerned directly with color: The words "color" and "light" and the three color names "white," "green" and "red."

Mr. Evans distinguished between form-vision and color-vision, and demonstrated that for the most part what an observer sees depends as much upon the observer and his experiences as it does upon the external reality which the light presents to the eyes of the observer. Turning to the seeing of color, and in particular to the seeing of colored objects, Mr. Evans showed by an extensive series of pictures that "seeing" actually is largely a matter of recognition of objects in terms of the properties which the observer believes to be possessed by those objects. From this it was demonstrated that the mind has the ability to see several things simultaneously at the same spot. Thus it follows that it is not entirely the physical or physiological facts which determine what the observer sees, but also to a great extent the knowledge of external reality as supplied by the observer's mind.

LIGHTING MEN from all of the Canadian Sections and Chapters joined efforts for the success of the recent Canadian Regional Conference. A few shown here are, left to right—Duncan Jones, Regional Vice-President, J. W. Bateman, Mr. Merson, D. J. McKenzie, H. L. Wright, and Joseph Thomas, Chairman, Montreal Section. Photo courtesy of *Electrical Digest*.

CANADIAN Regional Conference featured Pres. L. E. Tayler, shown here with H. L. Wright, General Chairman, and Duncan Jones, Regional V-P.

Outdoor Stage Lighting

An unusually well co-ordinated job of planned lighting was represented by the new outdoor stage and associated grandstands of the Canadian National Exposition. In describing this installation, Mr. Mayberry pointed out that the 1173-kw lighting load represented an expenditure of some $137,000 for lamps, lighting, and associated apparatus. The grandstand building not only provides a seating capacity of 21,250 for viewing the outdoor stage and racetrack activities, but contains a full complement of dressing rooms complete with showers, lavatories and rest rooms; also offices, kitchens, two enormous restaurants, and more than 12,000 sq. ft. of exhibit space. The lighting load of this building is 293 kw. From projection rooms built into the roof trusses some 80 ft. above the stage level, 630 kw in floodlights and high-intensity spotlights provide the general and special-effects lighting for the stage, including color. The distance of projection ranges from 100 to 350 ft. For cross lighting the stage and other special effects, there is a 250 kw lighting installation on the stage in floodlights and low-intensity spotlights.

It is possible to provide well above 1000 footcandles at the apron of the stage. When a big show is on, the lighting installation requires the services of 26 operators hidden in all parts of the stage and the grandstand roof, interlocked by a complete intercommunicating system which gives the director full and direct control.

As the Consulting Engineer Sees It

In discussing "The Consuting Engineer's Approach to Lighting Problems," Mr. Angus described the functions of the consulting engineer's office in correlating the several mechanical trades involved in a building project, such as heating, ventilating, plumbing, drainage, air-conditioning, fire control sprinklers, lighting and other electrical work. He pointed out that in the design of a building project, the actual lighting forms only one sub-division of the electrical trades, but that "because of its prominent appearance in a finished building, it is a subject dear to the heart of the client. Because the other branches usually are concealed and therefore forgotten, the lighting receives the full brunt of what may be termed generally uninformed opinion. Further, although our Illuminating Engineering Society has available much literature on good lighting practice, these recommendations as yet are relatively unknown outside the lighting profession."

Mr. Angus stated that it would be a great help to the consulting engineer if "the manufacturers or someone else would prepare a chart or nomogram which could be used for estimating fixture costs on a per-square-foot basis for the major different types of fixtures and lighting systems." He stated that the consulting engineer logically turns to the lighting specialist or sales representative for specialized and detailed technical information on special jobs or special equipment. However, he stated further that the sales representative should not be expected to furnish design plans and specifications for the consulting engineer, but that he should furnish detailed and specific information on specified equipment.

Supplementary Lighting

In speaking to the topic "Supplementary Lighting in Industry," Mr. Dean outlined the scope and nature of the work being done by his IES Committee on Supplementary Lighting, in preparing a forthcoming report. He emphasized the point that "the real purpose of supplementary lighting is to accomplish what cannot be done by general lighting in the way of making an object readily visible by influencing one or more of the four fundamental factors of seeing: contrast, brightness, time, and size." He stated that Chapter I of the forthcoming report would be given over to a discussion of scope and definition, Chapter II to a discussion of the fundamentals of seeing. Chapter III will be devoted to classification or cataloging of jobs. Rather than attempting to classify all jobs requiring supplemental lighting, the report will present fundamental principles. For example, on job classification, the first major breakdown is into two classes: (1) flat materials and (2) other than flat materials; these two main classes have three subdivisions each: opaque, translucent, and transparent. With a few possible exceptions, all seeing tasks will fall somewhere in these categories.

Mr. Dean stated that Chapter IV of the forthcoming report will be devoted to a classification of supplementary luminaires. This information is designed: (1) to serve as a guide to the specification of supplementary lighting on the basis of seeing requirements; (2) to provide a common means by which manufacturers can classify and list their various types of supplementary lighting equipment. In his closing comments, Mr. Dean stated: "In specifying supplementary lighting there are four steps to take: (1) Know the nature of the task itself; (2) know which of the four factors—contrast, brightness, time, size—can be used to make the seeing task easier; (3) know the illumination required to accomplish the desired result; (4) know the type of unit to provide this level of illumination, and the direction in which to apply it."

Fluorescent Developments

In discussing "Developments and Trends in Fluorescent Lamps" Mr. Barr stated that steady improvements are exemplified by two facts: (1) the announcement last year that the value of the 40-watt fluorescent lamp was eight time as great then as it was when introduced ten years before, as the result to price reductions and increases in light output and life; (2) this past year, according to Mr. Barr, has brought further increases in life and maintenance of light output so that today's lamp has doubled in value again.

In his discussion, Mr. Barr touched upon the development of the instant start, the slimline, the extension of the cold cathode lamp toward a standardized form somewhat comparable with slimline. He also touched upon the color developments and upon special shape, mentioning that the circline is growing in popularity and that it is expected to have three sizes—8 inch, 12 inch, and 16 inch—available within the next year. Mr. Barr stated that whereas recent developments have provided better lamps of longer life, and given greater flexibility in brightness and color, and simpler operating circuits, future developments may be expected to give even better lighting at still lower cost.

Professional Status Important

In his opening address as well as in his informal comments at various other sessions during the Toronto Conference, I.E.S. President Lee Tayler drew attention to the importance of the professional status of the Society as the prime agency for the promotion and correlation of growth and development in the lighting field. He stated that "the professional level of the Society is steadily mounting because the whole scope of illumination engineering and application is becoming more professional. . . . And so broad that the Society's membership and services embrace practically the whole of the electrical industry." President Tayler again urged that all Society members having engineering qualifications take immediate steps to take full advantage of local state registration as professional engineers. (For more on this, see p. 241-2 April Issue).

As to trends in lighting design, President Tayler predicted that ultimately lighting designs would be on the basis of brightness levels as a primary factor, with footcandles secondary. He pointed out also that the whole field of color is closely interrelated with light sources, qualities, and applications, in the production of a pleasant and effective lighting result for the user. President Tayler displayed samples of I.E.S. publications, emphasizing their value as sources of useful information on practical applications and urged that full use be made of them.

Regional Vice President Duncan M. Jones, in addressing the banquet gathering also dwelt upon the professional aspects of Society activities particularly with respect to the individual member. Likening the "lighting prescription" of the "doctor of applied lighting" to the prescription given to a client by a doctor of medicine, Mr. Jones pointed out that both had for their objectives the more healthful, more efficient, and happier functioning of the client, rather than detailed consideration of the ingredients making up the prescription. On this basis, he urged that "Like the medical doctor, we should not dwell upon the ingre-

dients of our recommendation such as footcandles, footlamberts, the characteristics of light sources, the thickness of metals. ... We can discuss these things among ourselves in our own engineering groups. ... To discuss such details with the client only confuses him and places him in such a dilemma that he rushes off to get similar prescriptions from others, then finally puts them all together and makes up his own lighting cure at his own cost, consequently losing faith in the specialist and, along with it, recognition that 'illumination' is a competent profession. ... We can obtain the confidence and faith of the client only by impressing him with *what the lighting recommendation will do for him and how to apply it so that he will obtain the greatest benefit from its use.* . . . If we fail to do this we simply become a great body of individuals providing 'patent medicine lighting' claiming everything under the sun from it. We have been doing this too long and it is holding up the advancement of our art and science."

OBJECTIVES FOR 1959

Dr. Ward Harrison, spoke on the topic "Some Objectives for 1959" at the concluding luncheon session of the Toronto Conference. His "predictions" included: marked improvement in the energy-conversion efficiency of the fluorescent lamp, 100 lumens per watt being regarded as a tenable objective for 1959 or sooner; the use of nothing but low-brightness lamps for all exposed applications; the common usage of levels of illumination up to 100 or 200 footcandles. Stating that the instant starting of fluorescent lamps has been accomplished "by ballasts of unreasonable size to bludgeon the lamps into starting" Dr. Harrison predicted for 1959 a means of coaxing lamps to start with small ballasts" pointing out that this can be done already by stepping up the frequency a few hundred cycles. (For information on this latter point, see "High Frequency Operation of Fluorescent Lamps" by John H. Campbell, page 125 I.E.S. Transactions for February 1948). The science of Electronics can be expected to contribute importantly to the field of lighting. Turning to another angle, Dr. Harrison urged that long before 1959 the words "intensity" and "artificial" should be eliminated from the vocabulary of the lighting profession. ... Both these words have negative reactions in so far as the general public is concerned, "intensity" being associated with such unpleasant sensations as intense heat, and "artificial" being associated with falsity. Hence reference to "artificial light" puts good lighting under an unwarranted cloud of suspected ancestry.

Beryllium in Fluorescent Lamps to Be Discontinued

After consultation with officials of the U. S. Public Health Service, Federal Security Agency, the major manufacturers of fluorescent lamps have stated that after June 30, 1949, they will no longer use beryllium phosphor in the manufacture of the fluorescent lamp, Dr. Leonard A. Scheele, Surgeon General of the Public Health Service, announced May 5, 1949. The announcement continues:

"For several years the industry has been working with medical men toward eliminating the dangers of beryllium in fluorescent lamps. Dr. James G. Townsend, chief of the Public Health Service's division of industrial hygiene, has been serving as chairman of the Medical Advisory Committee on Beryllium to the industry, which also includes the medical directors of the major manufacturers of fluorescent lamps.

"The announcement of the June 30 deadline for the use of beryllium in the lamps came after Dr. Townsend met recently with a group of executives of the major manufacturers of fluorescent lamps.

"In view of the fact that the manufacturing changeover in eliminating beryllium will not take place until the end of June, and that there is a stockpile of fluorescent lamps already manufactured, the Advisory Committee emphasized again the instructions it has issued in the past concerning the health hazards in the destruction of the fluorescent lamps.

"The committee reiterated its assertion to the general public that there is no danger whatever from the lamps when they are intact.

"The possible dangers come in the destruction of old lamps. Recently there have been reports of children who cut themselves on broken lamps, and that the cuts healed very slowly and often suffered swelling. The Committee repeated, however, its original statement that such cuts do not cause any general sickness or spread further on the body. Surgical care is necessary if the cut refuses to heal after a period of time.

"Although precautions should be taken against breathing the dust from fluorescent lamps, the Committee said, there is no record of any person suffering injury from breathing dust from the occasional breakage of a lamp, despite the millions of lamps in use.

DISPOSAL PROCEDURES SUGGESTED

"The Committee reissued its instructions on the safest way to dispose of used fluorescent lamps: If there are only a few lamps to be broken occasionally, they should be broken out of doors in a waste area or in a waste container, and the person breaking them should avoid breathing the dust or vapor that arises.

"The second situation in which there is a possible danger is the breaking of large numbers of fluorescent lamps, either intermittently or regularly, when hours may be occupied in the operation. Instructions in these cases are as follows:

a. Break lamps out of doors in waste disposal area or in ventilated hood. To avoid unnecessary dust, the breakage is best done within the waste container.

b. The operator should be supplied with, and required to wear, a respirator approved by the United States Bureau of Mines for toxic dusts.

c. Ultimate disposal of broken lamps should be such that the public and others will not be unduly exposed to powders. In situations where it is necessary to break the lamps within buildings, it should be done in an isolated room and in a hood, so as to minimize escape of dusts. Sufficient exhaust ventilation should be supplied to the hood to provide an air intake of at least 125 linear feet per minute at all hood openings.

"It is recommended that broken lamps not be disposed of in an incinerator, but either be thrown into water or in a dump where they are not likely to be disturbed with evolution of dust.

"Significant amounts of mercury vapor may be found in the air during the breaking up of fluorescent lamps. In situations where there is frequent or continuous exposure, measurements should be made of the amounts of mercury vapor in the air during the operation. If high levels are found, protection should be provided for the operator.

"In addition to Dr. Townsend, other members of the Advisory Committee are Dr. M. G. Carmody, Clifton Products Co., Paintsville, Ohio; Dr. T. L. Hazlett, Westinghouse Electric Corp., Pittsburgh, Pa.; Dr. J. M. DeNardi, Brush Beryllium Co., Cleveland, Ohio; Dr. W. M. Machle, New York City; Dr. A. D. Nichol, General Electric Co., Nela Park, Cleveland, Ohio; Dr. A. J. Vorwald, Director, The Trudeau Foundation and the Saranac Laboratory, Saranac Lake, N. Y.; Mr. C. R. Williams, Industrial Hygiene Field Service, Liberty Mutual Insurance Co., Boston, Mass.; Dr. B. S. Wolf, U. S. Atomic Energy Commission, New York, N. Y.; and Dr. Harry Tebrock, Medical Director, Sylvania Electric Products, Inc., Long Island City, N. Y."

Readers desiring additional and detailed information on methods and

procedures for disposing of old fluorescent lamps are referred to the following:

1. "Memorandum on the Precautions to Be Observed in the Breaking Up of Fluorescent Lamps," sponsored by the Medical Advisory Committee on Beryllium, distributed by the Saranac Laboratory, Saranac Lake, N. Y.
2. "Safe Disposal of Fluorescent Lamp Tubes" —Safety Reprint General No. 9, issued and distributed by National Safety Council, 20 North Wacker Drive, Chicago 6, Ill.

IT SEEMS TO ME

The Fallacy of the Louverall Ceiling

To the Editor:

In a recent issue of ILLUMINATING ENGINEERING there appeared what can be described as a provocative article entitled "The Fallacy of the Louverall Ceiling."

The title of this article, considered separately, is not particularly noxious to the subject if we delve into Webster's for a definition or two. The dictionary defines "fallacy" as—"False appearance; deception." There is certainly no argument here. Louverall ceilings can, and have, given many an otherwise drab and old-fashioned interior a deceptive (or false, if you will) appearance of modernity and integration not possible with exposed lighting equipments. In the field of dentistry, dentures have modernized many a drab and old-fashioned interior without any stigma resulting from the fact that they are also called "false teeth."

The authors of the paper[1] in question have, perhaps quite unintentionally, given the erroneous impression that *all* louverall ceilings are less efficient than luminous panels. This blunder is unfortunately strengthened by the statement that "We have compared, of course, only one installation of each kind but obviously the conclusions would be the same no matter how many systems were compared." If the authors had investigated a few more louverall systems they might have saved themselves the embarrassment of having this rather uncompromising statement refuted.

In an experimental room, described in a previous paper in which were compared lounverall ceilings of various finishes and materials, were also tested flat panels of translucent material. The panel material was tracing paper having a transmission factor of 67 per cent and a reflection factor of 26 per cent. This was the most efficient paper, lightwise, we were able to discover.

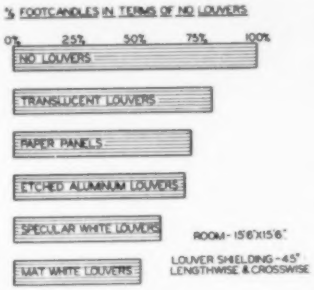


Figure A—Results of test conducted on louver shielding materials.

The results of the above test are shown in Fig. A. The luminous panels were found to be 4 per cent more efficient (from the utilization standpoint) than the aluminum louvers and 2 per cent more efficient than the specular white louvers (reflection factor 75 per cent). Comparing the luminous panels with the translucent louvers, as could be expected, shows an entirely different situation. In this comparison, the *translucent louvers were 12 per cent more efficient than the luminous panels.*

The problem of reflected brightness from objects of regard is one that is present in any lighting system having a direct component. In the case of louverall lighting this factor has at least been recognized. The point at which this reflected brightness becomes objectionable (*i.e.*—reflected glare) depends upon several variables among which are brightness of the light source, general level of illumination and specularity of the visual task. A brief study of the effect of increased illumination on seeing conditions with respect to translucent louverall ceilings has appeared in a previous issue of ILLUMINATING ENGINEERING.[1]

It is recognized that for any given lighting recess and lamp brightness, the diffusing media offered by the flat panels will reduce the brightness in the 0° (nadir) to 45° zone compared to that of a louverall system. It must be remembered, however, that louverall systems are not limited to any one type of light source. This permits the engineer a wide latitude in the selection of the proper light source to fit his particular needs. In case he requires not over 1000 foot-lamberts in the 0° to 45° zone he can use the 40-watt low brightness fluorescent lamp. In case his illumination level, or the type of area to be lighted, permits higher brightnesses in this zone, he can select the regular 40-watt fluorescent lamp, the 85-watt fluorescent lamp, or lamps of even higher brightness. Why the authors of the paper in question failed to acknowledge this possibility is not understood. Certainly a great many luminaires have no shielding in the 0° to 45° (or higher) zone and offer no choice to the user in the selection of permissible lamp brightnesses. The authors apparently are not concerned about these units but prefer to damn the lesser of the two evils.

The second paragraph of the article in question, in describing lighting, states that, ". . . . light is well distributed over the room." In the very next paragraph it states, "The louverall ceiling is the logical outcome of the preva-

Figure B—Typical louverall installation using translucent louvers.

lent but mistaken idea that visual comfort can be obtained only by keeping the surroundings dark and concentrating the light on the work." Out of this contradiction nothing worthwhile can be salvaged. The best answer to whatever it is the article is driving at is to show an installation of louverall in a typical small office since the article shows no supporting illustration. Fig. B shows such an installation using translucent louvers. The reader can draw his own conclusions.

The author's illustrations are unfortunate in that they do not, in all cases, apply to the subject under consideration. For instance, the two illustrations in their Fig. 1, photographed under incandescent lamps, are inferred to be indicative of the results under fluorescent louverall lighting. This is pure sophistry! In their Fig. 12 apparently the same visual task is photographed under an actual louverall installation. Note the vast improvement in legibility. In fact their Fig. 11, the same visual task under a luminous ceiling, contrary to showing an "entire absence of reflected glare," indicates that legibility is much poorer than that shown in Fig. 12, using louverall.

It is agreed that louverall ceilings are not the ultimate in the art of lighting. They do, however, offer the illuminating engineer an instrument of good efficiency and wide flexibility with which he can approach this goal. Far from being "doomed to oblivion," the louvered ceiling is, and will continue to be, a large factor in good lighting.

BENJAMIN S. BENSON, JR.
Benjamin Electric Mfg. Co.
Des Plaines, Illinois

To the Editor:

The only people who do constructive things in this world are opinionated. Of necessity, if some contributions to the advancement or improvement of any subject are to be made, the pioneer must solidify his concepts and then, through tenacious persistence, endeavor to gain recognition of them.

Because the writer has experienced some of the pains coincidental with a "different" approach, it has been with a sympathetic, although admittedly cynical and regretful eye that the battle for new lighting terminology, as conducted by Moon, Spencer et al, has been watched. The sympathy has come from a natural interest in any pioneering activity; the cynicism develops from a recognition of the fact that while the Moon-Spencer combine have discovered that "the Greks had a word for it" they have yet to learn that "a rose, by any other name, is still a rose"; the regret has stemmed from the fact that so much time and effort has been spent by capable individuals on what at best is a Quixotic jousting at windmills.

The foregoing may be interpreted as a preamble to a commentary on the Spencer, Buck, Wolfson paper entitled, "The Fallacy of the Louverall Ceiling." The preamble is the result of the inclusion in the paper of a claim that the terminology used (*i.e.* Pharosage, Helios, etc.) is "in accordance with modern engineering practice." Based on the number of current technical articles on illumination which do *not* use these terms, the statement is much more fallacious than any louverall ceiling which was ever hung.

In the paper, the authors open with a flat statement that the louverall ceiling is "doomed to oblivion." They then go forward to prove, apparently to their own satisfaction at least, why their dire predictions are correct.

In their title the authors used the word "fallacy" which by definition is "delusive reasoning." A most apparent fallacy is indicated throughout the entire paper, because the authors *condemn the louverall ceiling instead of the light source arrangement behind it.*

If the authors had continued their initial condemnation of bare fluorescent lamps combined with "egg-crate" louver shielding and had used their test results as supporting evidence, very little criticism could be forthcoming except from that group whose present approach is based on the idea that "if it's fluorescent — it's good — even if it's bare fluorescent."

Much of the data essential to an evaluation of their findings are lacking. For instance, tracing paper can have a very high transmission factor, but isn't nearly so practical as glass, which might not produce such convenient results. In any case, no information on transmission or reflective values is provided. Further, it must be assumed that the findings were all on an "initial" basis because it is not illogical to assume that large panels of any diffusing material would collect dirt within a not too extended period.

It is unfortunate that the authors devoted so much time and effort to "delusive reasoning" that the louverall ceiling is to be criticized when they actually are presenting one more case against a currently serious condition which is generally widespread throughout the lighting field. The introduction of the fluorescent lamp did not revolutionize the fundamental concepts of good lighting, but no one can deny that it did revolutionize lighting practice—and not always for the better. Brightness and brightness contrasts—direct or reflected—are still the major considerations in providing good seeing conditions. Yet, much of the present influence in lighting practice has apparently forgotten, or doesn't want to remember, that once upon a time anything over 2 or 2.5 candles per square inch was considered a potential glare source.

The authors, if they had concentrated their attack on louvered fluorescent lighting, would have found plenty of additional substantiating evidence by picking at random almost any fluorescent fixture of any manufacturer and comparing it with their luminous ceiling. Unfortunately, their conclusions are based on fallacy and to prove their error, I refer them to the lighting system designed by Mr. Howard Sharp wherein silvered bowl incandescent lamps were used in back of a louverall ceiling to provide a noteworthy illumination effect.

I would like to suggest that the authors continue their experiments on a wider approach and with an element of time introduced to determine whether a luminous panel ceiling or an indirectly lighted ceiling will maintain a more satisfactory continuous lighting result.

J. L. KILPATRICK
Slivray Company, Inc.
New York, N. Y.

To the Editor:

I believe the authors have done well in calling attention to a feature of louverall we are apt to overlook, namely, that as currently used, it may produce bothersome reflected glare.

However, when the authors infer that the cellular ceiling is "doomed to oblivion" and "inherently contradicts the principles of best seeing" it would seem that in a desire to stress a specific point, they may have overreached somewhat.

The authors state, "It is reflected glare that is so bothersome to the worker." After 36 years in the lighting business I conclude that extremely few people are disturbed by, or even conscious of reflected glare while a great many are bothered by and complain about direct, or "discomfort" glare. The same opinion has been voiced by others in the I.E.S. Conferences.

For eight years the writer occupied

[1]Benson, Benjamin S., Jr.: "Louverall Lighting Techniques." ILLUMINATING ENGINEERING, Vol. XLIV, p. 89 (February, 1949).

an office lighted by surface-mounted fluorescent fixtures having large bottom panels of clear, prismatic glass. As regards reflected glare the effect was the same as louverall. Through the 0° - 45° zone practically the full brightness of the lamps was exhibited towards the work. Certainly veiling glare was present as it is with any overhead lighting system, and this includes the luminous ceiling advocated by the authors.

I was reminded of this condition by "experts" and reminded myself from time to time, but otherwise was entirely unconscious of the "horrible" situation.

Some 3000 office workers in the same utility organization were provided with this identical lighting, with no record of complaint from reflected glare, although there were many on the score of direct glare caused by bright side panels, high brightness streaks on the plaster immediately above the fixtures, etc.—items incident to the development of what was later designated the URC "Research" luminaire.

The authors mention "thousands of complaints concerning fluorescent lighting." The writer has listened to many of them, ranging from upset stomach to falling hair, but the great majority sifted down to direct glare and excessive brightness contrasts.

If office workers habitually worked on glazed cover stock, which the authors have chosen for two of their illustrations, then we might agree that the lamp images would be objectionable. How many do?

Another photograph used by the authors compares print under luminous ceiling, and louverall with incandescent lamps. The caption states "similar effects are obtained with fluorescent lamps."

This hardly seems reasonable considering the fact that the incandescent lamp is a point-source, and in the sizes used in commercial lighting ranges from 15 to 1500 times as bright as the fluorescent T12 40-watt white lamp.

The authors state "with ceiling lighting there is no possibility of reflected glare." About the most unbearable glare the writer ever experienced arose from attempts to furnish intensities of 100 footcandles by indirect (ceiling) illumination, where the entire ceiling is in the order of 250-300 footlamberts. Dr. Ward Harrison, in a discussion printed in ILLUMINATING ENGINEERING, points out that the borderline between comfort and discomfort for such a system is a ceiling brightness of 150 footlamberts.

The authors' luminous ceiling provided 50 footcandles initially (we judge from the text) or say 25 footcandles maintained, which is well below modern practice for office lighting. Do they contend that for a 65 footcandle maintained illumination "there is no possibility of reflected glare"?

Even low intensities of ceiling illumination cause veiling glare which may be more troublesome than any other, since it is difficult to maneuver into position where the eye avoids it. The writer can cite one instance after another (industrial) where ceiling illu-

LIGHTING CALENDAR

Society Events

June 6, 1949—Residence Lighting Committee, E. W. Commery, Chairman, Electrical Testing Laboratories, Inc., New York, N. Y.

June 6-7, 1949—East Central Regional Conference, Harrisburg, Pa.

June 7, 1949—Public Relations and Information Committee, J. M. Hickerson, Chairman, Room 1213, 110 E. 42nd St., New York, N. Y.

June 8, 1949—Meeting of I.E.S. Council, 51 Madison Avenue, New York, N. Y.

June 9, 1949—Local Activities Conference, New York, N. Y.

June 9, 1949—Meeting of Council Executive Committee, New York, N. Y.

June 28-29, 1949—Committee on Lighting of Central Station Properties, A. A. Brainerd, Chairman, Philadelphia Electric Co., Philadelphia, Pa.

July 13, 1949—Meeting of I.E.S. Executive Committee, Philadelphia, Pa.

September 19-23, 1949—National Technical Conference, French Lick Hotel, French Lick, Ind.

Industry Events

June 5-9, 1949—The American Society of Refrigerating Engineers, 36th Spring Meeting—Cruise; St. Lawrence and Saguenay Rivers starting from Montreal

June 20-22, 1949—American Society of Heating & Ventilating Engineers, Semi-Annual Meeting, Minneapolis, Minn.

June 10, 1949—Society of Motion Picture Engineers Regional Meeting, Toledo, Ohio.

June 20-22, 1949—American Society of Heating & Ventilating Engineers, Semi-Annual Meeting, Hotel Nicollet, Minneapolis, Minn.

June 20-24, 1949—American Institute of Electrical Engineers, Summer General Meeting, New Ocean House, Swampscott, Mass.

June 20-24, 1949—American Society for Engineering Education, Annual Convention, Rensselaer Polytechnic Institute, Troy, N. Y.

June 27 to July 1, 1949—New York Lamp Show, Hotel New Yorker, New York, N. Y.

June 28-30, 1949—Canadian Electrical Association, Annual Convention, Banff Springs Hotel, Alberta, Canada.

July 2-9, 1949—New York State Association of Electrical Contractors & Dealers, Inc., Golden Anniversary Convention, Saranac Inn, N. Y.

August 23-26, 1949—American Institute of Electrical Engineers, Pacific General Meeting, Fairmont Hotel, San Francisco, Calif.

August 26 to September 10, 1949—Engineering and Mining Exhibition, London, England.

October 11-14, 1949—American Standards Association, Annual Meeting, Waldorf-Astoria Hotel, New York, N. Y.

October 17-21, 1949—American Institute of Electrical Engineers, Netherland Plaza Hotel, Cincinnati, Ohio.

October 24-28, 1949—37th National Safety Congress, Chicago, Ill.

Nov. 8-11, 1949—National Electrical Contractors Association, 1949 Annual Convention, Houston, Texas.

November 13-18, 1949—National Electrical Manufacturers Association, Chalfonte-Haddon Hall, Atlantic City, N. J.

December 4-7, 1949—The American Society of Refrigerating Engineers, 45th Annual Meeting, Edgewater Beach Hotel, Chicago, Ill.

mination has been discarded in favor of directional equipment with louvers whereby reflected glare was controlled.

Today literally millions are working unconcernedly under louvered fluorescent lighting. The widespread acceptance and volume attained by this form is unprecedented in the history of lighting. Of course all of these millions may be suffering from reflected glare, but I believe the authors would find it difficult to convince any considerable number of them that this was so. I believe that rather than being "doomed to oblivion" louverall will increase in popularity because of its simplicity, practical shielding of bare lamps, high maintenance factor, elimination of hanging fixtures, concealment of air-conditioning ducts, etc., etc. No doubt it can and will be improved. In the meantime let's not throw too many bricks at it.

EDWIN D. TILLSON
Lighting Products Inc.
Highland Park, Ill.

To the Editor:

The writers Spencer, Buck and Wolfson in their article "The Fallacy of the Louverall Ceiling," I believe, are very arbitrary. To select but one statement they make the following observation:

"We have compared, of course, only one installation of each kind but obviously the conclusions would be the same no matter how many systems were compared. The trouble with the louverall ceiling is caused by the bare fluorescent lamps which have high brightness and therefore cause reflected glare, irrespective of the size, shape or material of which the louvers are made."

The size and shape of tubes, louvers and relative spacings does have a very definite effect in visual comfort and is of real benefit especially on sales work.

Although their complaints are well founded and merit much thought, luminous ceilings run into the brightness and brightness contrast that are very objectionable as we all found in high level totally indirect lighting systems. These brightness studies are eloquently explained by Messrs. Putnam and Waite in "Practical Schoolroom Brightness Ratios," ILLUMINATING ENGINEERING, Vol. XXXIV, No. 3, p. 173 (March, 1949).

Neither system is without glaring fault and each does have a particular application advantage; maybe a solution will be a translucent combination.

W. T. WALTERS
Public Service Co. of Oklahoma
Tulsa, Okla.

ABOUT PEOPLE

Effective April 1, 1949, **John R. Ford** was appointed General Sales Manager of the Jefferson Electric Co., Bellwood, Illinois. Mr. Ford has been associated with Jefferson for the past nineteen years in various capacities. He was their Milwaukee representative from 1930 to 1932, at which time he was transferred to Minneapolis. From 1935 to 1944 he covered the northwest area for the company, headquartering in Seattle, Washington.

John W. Fleisher has been appointed to head the new sales organization known as Motor City Sales District, recently established by the General Electric Lamp Department in Detroit, Michigan. The new district is one of several being organized by General Electric in its nationwide sales organization. The district will be responsible for the sale of miniature, automotive, sealed beam and specialty type lamps in its territory, which includes Detroit, Flint, Lansing, Pontiac, Bay City, Saginaw and Dearborn. The previous Michigan Sales District with Earl Anderson as manager, continues to handle all other lamp sales except the types now concentrated in the new Motor City Sales District.

John E. Fox, manager of industrial relations for the Westinghouse Lamp Division, Bloomfield, N. J., for the past three years, has been appointed staff assistant to Ralph C. Stuart, Vice-President in charge of the Division. Mr. Fox will handle special assignments as well as direct overall personnel and industrial relations activities in all Division plants.

Edward L. Ogden has been appointed supervisor of industrial relations in Bloomfield and Belleville plants of Westinghouse, a new position.

Harold H. Maass has been promoted from Production Manager and Plant Superintendent of Colonial Electric Products, Inc., East Paterson, N. J., to director of the New Business Development Division of the company, according to Charles L. Sabatini, president of Colonial. Prior to joining Colonial Electric Products in 1945, Mr. Maass was variously design and production supervisor for Kurt Verson Co., vice-president in charge of production for Viking Products Corp., and development engineer for Sperry Corp.

Five appointments to top positions in the sales organization of General Electric Lamp Department at Nela Park have been announced. The appointments became effective June 1.

O. H. Young, who has been assistant to P. D. Parker, general sales manager, was advanced to the position of assistant manager of the General Sales Division, acording to an announcement by F. F. Harroff, manager of the Lamp Department. In addition, managers for the Sales Division's four major functional operations were named by Mr. Parker, as follows: Utility and fixture promotion, **E. D. Stryker**; quantity consumer sales, **R. E. Worstell**; retail sales, **T. C. Ohart**; and original installation sales, **W. E. Davidson.**

D. M. Salsbury, president of Westinghouse Electric Supply Co., New York, was elected president of the National Electrical Wholesalers' Association following the general session of the Association's 41st Anniversary Convention, held at the Netherland Plaza Hotel, Cincinnati, May 4. Also announced was the election of **R. M. Johannesen**, Johannesen Electric Co., as vice-president and chairman of the Apparatus and Supply Division; **W. G. Pierce, Jr.**, Pierce-Phelps, Inc., Philadelphia, as vice-president and chairman of the Appliance Division. **George F. Hessler**, Graybar Electric Co., Inc., New York, and **C. E. Mason**, Novelty Electric Co., Philadelphia, were elected to the Executive Committee.

OBITUARY

The Toronto Section of I.E.S. has reported the loss of a highly respected and well known member in the sudden death on April 16 of William H. Woods, engineer in charge of street lighting, Toronto Hydro-Electric System.

When the Toronto Chapter was organized in May, 1921, Mr. Woods was its first secretary, and later served as chairman for two seasons, 1923-1925. Always active in Society affairs in the Toronto district, Mr. Woods was especially active also in the national affairs of I.E.S. He was a regular attendant at all of the Society's meetings for many years, and served as a member on a number of national committees. He was currently a member of

the Talent Sub-Committee on Lighting Study Projects of the Street and Highway Lighting Committee, and the Sub-Committee of Section and Chapter Representatives of the Sustaining Membership Committee. Mr. Woods' last paper before a conference of I.E.S. was at the New Orleans conference in 1947, at which he presented his paper "Modernizing a City Street Lighting System," subsequently published in the February, 1948, issue of ILLUMINATING ENGINEERING.

NEW MEMBERS

At the meeting of the Council Executive Committee held May 11, 1949, in Hartford, Conn., the following were elected to membership:

ALAMO CHAPTER

Associate Members:

Cantey, Richard L., Westinghouse Electric Supply Co., San Antonio, Texas.

Pitts, Harry T., Harry T. Pitts Electric Co., San Antonio, Texas.

Scrutchin, Thomas W., Lighting Fixture Supply Co., San Antonio, Texas.

BALTIMORE CHAPTER

Associate Members:

Dahn, Ralph, 2001 Bryant Ave., Baltimore, Md.

Mager, Julian D., Air Conditioning and Refrigeration Institute, Baltimore, Md.

BRITISH COLUMBIA CHAPTER

Associate Members:

Andow, Don, J. F. McMillan Sales, Ltd., Vancouver, B. C., Canada.

Langdon, G., H. J. Langdon & Son, Victoria, B. C., Canada.

Williams, C. H. E., Jr., C. H. E. Williams Co., Ltd., Vancouver, B. C., Canada.

Student Member:

Harvey, Norman L., University of British Columbia, Vancouver, B. C., Canada.

CAPITAL SECTION

Member:

Douglas, Charles A., National Bureau of Standards, Washington, D. C.

Associate Members:

Anderson, W. A., U. S. Government Printing Office, Washington, D. C.

Rogers, J. L., Rex Equipment Co., Washington, D. C.

CAROLINAS CHAPTER

Members:

Edwards, Jesse W., Noland Co., Inc., Columbia, S. C.

Springs, Alexander, Electrical Contracting & Engineering Co., Charlotte, N. C.

Associate Members:

Baer, J. R., Mill Power Supply Co., Charlotte, N. C.

Barnes, MacKenzie D., Westinghouse Electric Supply Co., Charlotte, N. C.

Blackmon, W. Earl, Noland Co., Inc., Durham, N. C.

Ducker, A. L., Jr., General Electric Co., Greensboro, N. C.

Gile, W. B., W. B. Gile & Associates, Charlotte, N. C.

Glover, Albert K., Textile Mill Supply Co., Charlotte, N. C.

Goodall, Henry R., Jr., Graybar Electric Co., Inc., Charlotte, N. C.

Jerry, J. J., Crouse-Hinds Co., Charlotte, N. C.

Massey, Ladson M., Mill Power Supply Co., Charlotte, N. C.

Person, Rufus M., Jr., Mill Power Supply Co., Charlotte, N. C.

Williams, Frank J., Line Material Co., Charlotte, N. C.

CENTRAL NEW YORK CHAPTER

Associate Member:

Dalton, Charles Chester, Corning Glass Works, Corning, N. Y.

CHICAGO SECTION

Members:

Koga, Albert M., Hub Electric Co., Chicago, Ill.

Martin, B. J., B. J. Martin & Co., Chicago, Ill.

Associate Members:

McDonnell, E. F., Jr., Commonwealth Edison Co., Chicago, Ill.

Miller, C. V., Joslyn Mfg. & Supply Co., Chicago, Ill.

Millholin, Leslie M., Jr., Westinghouse Electric Corp., Chicago, Ill.

O'Connell, Paul J., Globe Lighting Products, Inc., New York, N. Y.

Student Member:

Leiser, Richard C., Wilson Junior College, Chicago, Ill.

CLEVELAND SECTION

Member:

Tugman, J. L., General Electric Co., Nela Park, Cleveland, Ohio.

Associate Members:

Haynes, Robert C., Westinghouse Electric Corp., Cleveland, Ohio.

McKay, George T., Unistrut Service Co. of Ohio, Cleveland, Ohio.

Mandalfino, Emil J., Holdenline Co., Cleveland, Ohio.

Scott, Robert T., Westinghouse Electric Corp., Cleveland, Ohio.

Trapani, Umberto L., Westinghouse Electric Corp., Cleveland, Ohio.

CONNECTICUT CHAPTER

Member:

Porter, J. C., General Electric Supply Corp., Hartford, Conn.

Associate Member:

Quinn, Quentin Q., Connecticut Light & Power Co., Waterbury, Conn.

CORNHUSKER CHAPTER

Member:

Sechrist, Gilbert H., Prof., University of Nebraska, Lincoln, Neb.

Associate Members:

Aldrich, Oliver E., Younker-Davidson, Sioux City, Iowa.

Anderson, Roland A., Anderson Electric Co., Wahoo, Neb.

Clement, Harry R., Consumers Public Power District, Columbus, Neb.

Halpin, T. S., E. I. du Pont de Nemours Co., Inc., Omaha, Neb.

Hudson, D. E., Electric Supply Co., North Platte, Neb.

Jorgensen, Henry, Jorgensen Electric Co., St. Paul, Neb.

Stevens, R. L., Graybar Electric Co., Inc., Omaha, Neb.

EASTERN PENNSYLVANIA CHAPTER

Associate Members:

Bane, William Z., Commonwealth Bldg., Allentown, Pa.

Bergren, John A., The Kawneer Co., New York, N. Y.

Eilenberger, Ralph W., Pennsylvania Power & Light Co., Stroudsburg, Pa.

Hammerman, D. L., D. L. Hammerman Co., Scranton, Pa.

Hoffman, Luke F., 338 N. Sixth St., Allentown, Pa.

Kemen, William Z., Kemen Lamp & Lighting Studio, Wilkes Barre, Pa.

McManus, Frank J., H. H. Roth, Wilkes Barre, Pa.

FLORIDA CHAPTER

Associate Members:

Baker, Roland C., General Electric Supply Corp., Jacksonville, Fla.

Conant, R. A., Raybro Electric Supplies, Inc., Miami, Fla.

Escott, Pat, Russell Raine & Associates, Coral Gables, Fla.

Furman, Nat, Sta Brite Fluorescent Mfg. Co., Miami, Fla.

Hess, David, David Hess Fixture Co., Inc., Miami, Fla.

Kirby, Cecil E., Kirby Tuttle Co., Inc., Miami, Fla.

FOREIGN NON-SECTION

Member:

Demestre, Luis F., L. F. Demestre y Cia, San Rafael No. 474, Habana, Cuba.

Associate Members:

Fauconnier, Albert, Fabrique Nationale de Lampes Electriques, S. A.,

145 Rue Drootbeek, Brussels II, Belgium.

Lennox, William R., Firma John G. Eman, Oranjestad, Aruba, Netherland Antilles.

Swierstra, R., N. V. Philips Gloeilampenfabrieken, Eindhoven, Holland.

Georgia Section

Member:

English, Ted R., Noland and Company, Macon, Ga.

Inland Empire Chapter

Associate Member:

Desgrood, Ted J., Verd-A-Ray Corp., Toledo, Ohio.

Iowa Section

Associate Member:

Jones, Merle, Iowa Public Service Co., Waterloo, Iowa.

Michigan Section

Members:

Catanach, R. W., Snyder & McLean, Detroit, Mich.

Funk, Paul V., Hyde & Bobbie, Detroit, Mich.

Associate Member:

Van Tassel, Edward C., The Bryant Electric Co., Chicago, Ill.

Milwaukee Chapter

Associate Members:

Harsh, M. C., Line Material Co., Milwaukee, Wis.

Hart, Clarence A., Milch Electrical Wholesale Supply Co., Racine, Wis.

Pleyte, Allan P., City of Milwaukee, Milwaukee, Wis.

Student Members:

Firehow, Kenneth Glenn, University of Wisconsin, Madison, Wis.

Foote, Warren E., University of Wisconsin, Madison, Wis.

Henke, Harley R., University of Wisconsin, Madison, Wis.

Holcombe, Richard C., University of Wisconsin, Madison, Wis.

Yehl, Eugene J., University of Wisconsin, Madison, Wis.

Montreal Section

Members:

Keenan, A. E., Canadian General Electric Co., Ltd., Quebec City, Que., Canada.

Payson, H. R., Canadian General Electric Co., Ltd., Quebec, Que., Canada.

Sarault, G. E., Tasse, Sarault et Associes., Quebec, Que., Canada.

Associate Members:

Germain, M., L. D. G. Products, Ltd., Montreal, Que., Canada.

Labbe, Viateur, The Shawinigan Water & Power Co., Victoriaville, Que., Canada.

Lafontaine, Jean, Shawinigan Water & Power Co., Three Rivers, Que., Canada.

Lemieux, J. A., The Shawinigan Water & Power Co., Montreal, Que., Canada.

Maritime Chapter

Member:

Beazley, W. P., Northern Electric Co., Ltd., Halifax, N. S., Canada.

Associate Members:

Hains, Alfred William, Hains' Electric Service, Sackville, N. B., Canada.

MacElmon, E. L., Board of School Trustees, St. John, N. B., Canada.

McElman, W. F., Franke-Levasseur & Co., Ltd., Montreal, Que., Canada.

White, John J., Century Electric Co., Sussex, N. B., Canada.

New England Section

Associate Members:

Parsons, K. L., Prof., University of Maine, Orono, Me.

Waddell, John G., Electric Institute of Boston, Inc., Boston, Mass.

New Orleans Chapter

Member:

Des Angles, John P., James M. Todd & Associates, New Orleans, La.

Associate Member:

Cox, Charles W., State Eectric Inc., Baton Rouge, La.

New York Section

Members:

Anderson, Herbert A., Duro Test Corp., North Bergen, N. J.

Gishlick, Herbert E., The Austin Co., New York, N. Y.

Rae, Gene G., Holophane Company, Inc., New York, N. Y.

Associate Members:

Blitzer, William F., Corona Corp., Jersey City, N. J.

Calamia, Thomas L., Kelvin Lighting Corp., New York, N. Y.

Ferguson, John A., New York State Public Service Commission, Albany, N. Y.

Hoyt, George D., Parsons, Brinckerhoff, Hall & MacDonald, Inc., New York, N. Y.

Jatz, David., General Lighting Products Co., Newark, N. J.

Kupeez, Ludwig, United Cold Cathode Light Corp., East Rockaway, N. Y.

Markush, E. U., 138 Lexington Ave., New York, N. Y.

Meyers, Melvin B., Walker Electric Co., Brooklyn, N. Y.

Spiegel, George, Public Service Electric & Gas Co., Newark, N. J.

Storm, John E., Parsons, Brinckerhoff, Hall & MacDonald, Inc., New York, N. Y.

Student Member:

Hanis, Leopold M., Rutgers University, New Brunswick, N. J.

Northern California Section

Associate Members:

Ashton, William J., Columbia Electric & Mfg. Co., San Francisco, Calif.

Curtis, Clyde, Acme Fluorescent Sales Co., Oakland, Calif.

Denke, Robert, 1317 Hyde St., San Francisco, Calif.

Kommers, T. A., Fluorescent Fixtures of California, San Francisco, Calif.

Neikirk, W. Thom, Line Material Co., San Francisco, Calif.

Wirth, Lucile Purdue, City of Hayward, Hayward, Calif.

Student Members:

Ahlborn, Gale, University of California, Berkeley, Calif.

Isenberg, Ernest S., Stanford University, Palo Alto, Calif.

Ohio Valley Section

Member:

Voelker, Jack, Pittsburgh Reflector Co., Cincinnati, Ohio.

Associate Member:

Stallard, Joseph C., General Electric Supply Corp., Lexington, Ky.

Student Member:

Gaible, Jene C., University of Cincinnati, Cincinnati, Ohio.

Oregon Section

Associate Member:

Whitney, J. Francis, Eugene Water & Electric Board, Eugene, Ore.

Ottawa Chapter

Associate Member:

Shibley, Lawrence H., Dept. of Transport, Civil Aviation Branch, Ottawa, Ont., Canada.

Philadelphia Section

Associate Member:

Richardson, Stanton C., McHugh Electric Co., Wilmington, Del.

Pittsburgh Section

Member:

Wiesmann, Edward T., 602 Wabash Bldg., Pittsburgh, Pa.

Associate Member:

Gerome, Henry M., West Penn Power Co., Charleroi, Pa.

Puget Sound Section

Members:

Huber, Henry R., Benjamin Electric Mfg. Co., Seattle, Wash.

Scheyer, C. A., Puget Sound Power & Light Co., Seattle, Wash.

(Continued on page 21A)

ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

PRESENTS . . .

A Merit Award Equipment Section

FEATURING THE ADVERTISEMENTS OF COMPANIES WHOSE LIGHTING EQUIPMENT WAS INCORPORATED IN AWARD-WINNING INSTALLATIONS WHICH WERE PLACED IN NATIONWIDE COMPETITION AT THE

Third International Lighting Exposition

Chicago, Illinois . . . March 29-April 1, 1949

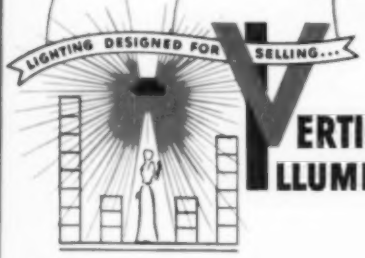
CURTIS FIXTURES FEATURED IN Gold Seal Award No. 4[illegible] Gold Seal Award [illegible] pages [illegible] and [illegible]

Tomorrow's AWARD *Winner!*

THE CURTIS "*Store-Liter*"

CATALOG No. 7502-CLH

Curtis design and engineering again reveals the mark of a winner for future competition with the new "STORE-LITER." ● New 75-watt, T-12, 96-inch Fluorescent Lamps ● Instant Starting ● More Lumens Per Foot of Lamp ● 96-inches of Uninterrupted Light ● High Vertical Illumination ● Plastic Side Panels ● Low Installation Cost ● Ease of Maintenance ● Individual Mounting or Continuous Lines . . . truly a modern luminaire with a bright wide-awake appearance that provides "Lighting Designed for Selling."



VERTICAL ILLUMINATION

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1. Benjamin "Shield-Flo" "Grid System" Fluorescent Lighting in a Chicago Area Metal Fabricating Shop, 70 ft-c at 30" from floor by R. G. Geyer and W. F. Carson, Public Service Co., Maywood, Illinois.
2. Benjamin "Twin-Flo" Fluorescent Lighting at Bemis Bros., Omaha, 45 ft-c av. intensity, by John Sinovich, Evans Electrical Constr. Co., Omaha.
3. Benjamin Floodlights & Pit Lights at Lever Bros.' New Office Bldg., Cambridge, Mass., 70 Footlamberts by P. D. Dempsey, Geo. H. Wahn Co., Boston, Mass.

4, 5, 6, 7, 8. Benjamin "Sky-Glo" Lighting

4. at a mens' clothing store, Winston-Salem, N.C.; Footlamberts per sq. in., Ceiling: 67; Walls: 3.17; Floors: 4.09; by Edgar A. Parvin, Noland Co., Inc., Winston-Salem, N.C.
5. at Peoples City Bank, McKeesport, Pa. ft-c at 30" above floor: Banking area 45; Teller's 60; by Hugh S. James and John B. Martin, Duquesne Light Co., Pittsburgh, Pa.
6. at Mueller Harkins Automotive Sales, Tacoma, Wash. 76 ft-c at 30" above floor; by R. H. Fewell, Westinghouse Elect. Supply Co. and B. L. Payson, Wire Electric Co., Tacoma, Wash.
7. at Central Trust Co., Rochester, New York, a Gold Seal Merit Award to R. Bruce Thompson, General Electric Supply Corporation, A. G. Alexander, New York City, Consulting Architect, T. H. Greene Electric Co., Rochester, Electrical Contractor. Average Footcandles in Public Area 90 Footcandles!
8. at Thompson Store for Men, Downers Grove, Ill. av. ft-c 66 by Donnie Howell, Downers Grove Elect. Co. and Paul Fisher, Western United Gas & Elect. Co.

Send for Bulletin AD5579 — Contains a Representative List of Benjamin "Sky-Glo" Installations arranged by States and Cities.

BENJAMIN ELECTRIC MFG. CO., Dept. I, Des Plaines, Ill.

Every winner is to be congratulated on his demonstration of skill in the application of the principles of advanced modern-day illuminating engineering.

As every lighting man knows, however, there are unseen values in every lighting installation which cannot be measured in a competition. These values have to do with the sustained efficiency of the units, the ease of maintenance, the efficiency of the light reflecting areas after years of service.

It is these values which win customer good will long after original costs are forgotten. These are the values which tens of thousands of lighting men assure to their customers by the specification of Benjamin Lighting Equipment.

BENJAMIN ELECTRIC MFG. CO.
Dept. I, Des Plaines, Illinois

BENJAMIN
Lighting Equipment
Distributed Exclusively Through Electrical Wholesalers

Congratulations, partners

AND THANKS FOR USING

GUTH

precision-planned FIXTURES TO WIN YOUR LIGHTING AWARDS!

★ GOLD SEAL AWARD

EUGENE M. FAHEY — **J. A. HEFFERNAN**

Public Service Elec. & Gas Co.
Newark, N. J.

★ MERIT AWARDS

★ **WILLIAM G. HOCK, JR.**
Philadelphia Electric Co.
Philadelphia, Pa.

★ **EARL A. COOK**
The Union Light, Heat & Power Co.
Covington, Ky.

★ **ALEX MORRISON**
Dayton Power & Light Co.
Dayton, O.

★ **GEORGE W. SHIELDS**
Public Service Elec. & Gas Co.
Patterson, N. J.

★ **BYRON B. BROWN**
Cincinnati Gas & Elec. Co.
Cincinnati, O.

★ **ROBERT W. BROWN**
Cincinnati Gas & Elec. Co.
Cincinnati, O.

★ **RAYMOND B. McFARLAND**
Central Maine Power Co.
Lewiston, Me.

★ **JOHN F. MURPHY**
Duquesne Light Co.
Pittsburgh, Pa.
with Harry Prothero, Elec. Cont.
Beaver, Pa.

★ **C. T. TROY &**
H. L. SAVACOOL
Northern Penna. Power Co.
Towanda, Pa.

★ **RAYMOND L. JOHNSON, JR.**
Public Service Elec. & Gas Co.
Jersey City, N. J.

★ **JAMES C. BINGHAM**
Cincinnati Gas & Elec. Co.
with Wm. P. Foster, Arch.
Cincinnati, O.

★ **EDWIN A. EVERETT**
Ohio Public Service Co.
Mansfield, O.

★ **WILLIAM W. HUNTLEY**
Miss. Power & Light Co.
Jackson, Miss.

★ **GERALD V. KEELEY**
Central Public Service Co.
Beardstown, Ill.
with Norbert Maas, Elec. Cont.

★ **FRED B. AUSDENMOORE**
Cincinnati Gas & Elec. Co.
with B. Pepinsky, Arch.
Cincinnati, O.

★ **SEB C. RENTZ**
Cincinnati Gas & Elec. Co.
with H. Neil Jackson, Arch.
Cincinnati, O.

★ **RICHARD KUENZEL**
Cincinnati Gas & Elec. Co.
with G. Godley, Arch.
Cincinnati, O.

The prize-winning installations these men created with GUTH fixtures are eloquent proof that close teamwork between manufacturer and designer assures top-quality Planned Lighting.

Whoever or wherever you are, you'll get *better results* when you join hands with

Guth

YOUR TEAMMATE IN *precision-planned* LIGHTING

LIGHTING

THE EDWIN F. GUTH COMPANY / ST. LOUIS 3, MISSOURI

Leaders in Lighting Since 1902

914

45° SHIELDING?
YES Longitudinally and Transverse

80% LIGHTING EFFICIENCY?
YES By laboratory test

LOW SURFACE BRIGHTNESS?
YES Average — 551.44 foot lamberts.

ALUMINUM OR WHITE?
YES Choice of processed aluminum or baked white enamel.

LOW BRIGHTNESS CONTRAST?
YES 90% of fixture surface illuminated! Widespread light on ceiling! No dark areas — no objectionable contrast.

For 2-40 watt fluorescent or 2-T12 slimline
Substantial, one-piece shields?
Hinged from either side or removable?
Half indirect and half direct lighting?
EMPHATICALLY
YES!

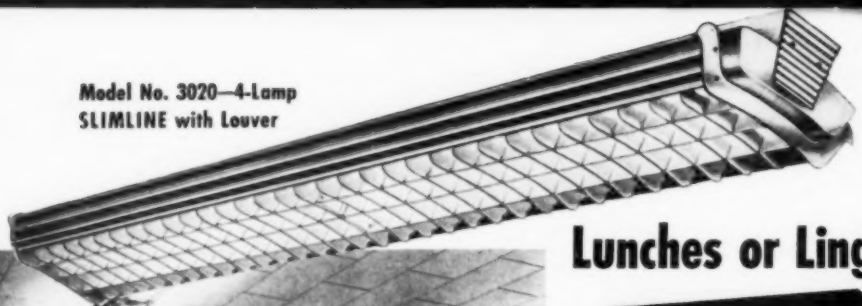
No. 5050
For 2 — 40 watt fluorescent lamps
No. SL-5050
For 2 — T12 slimline lamps

WITH GARCY'S NEW
Visualier

WRITE FOR DETAILED LITERATURE

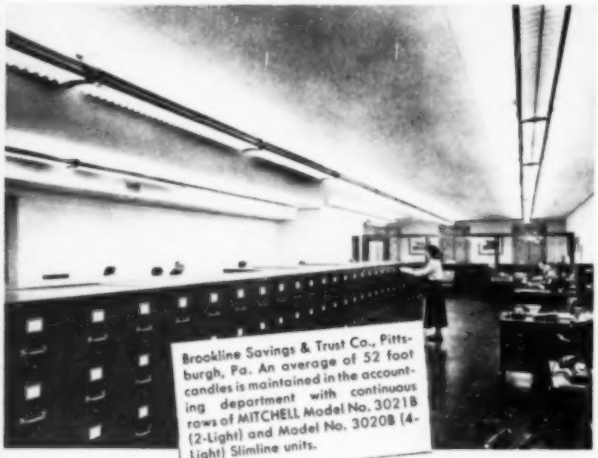
GARDEN CITY PLATING & MANUFACTURING COMPANY
1766 NORTH ASHLAND AVENUE • • • CHICAGO 22, ILLINOIS

MITCHELL EQUIPMENT FEATURED IN Gold Medal Award No. 366 and other Merit Awards, Nos. 13, 305, 340, 354, 355, 356, 357



Model No. 3020—4-Lamp
SLIMLINE with Louver

Jim's Grill, Huntington, West Virginia. MITCHELL Model No. 3020B Slimline fixtures provide a bright, inviting atmosphere in this well-designed coffee shop. Customers and employees applaud the lighting.



Brookline Savings & Trust Co., Pittsburgh, Pa. An average of 52 foot candles is maintained in the accounting department with continuous rows of MITCHELL Model No. 3021B (2-Light) and Model No. 3020B (4-Light) Slimline units.

Dan's Dollar Store, Donora, Pennsylvania. An exceptional selling atmosphere created by the use of MITCHELL Model No. 3021B Slimline units, with Model No. 348 Spotlites for effective accent lighting.

Lunches or Lingerie..

MITCHELL

"SLIMLINE" Lights them All!

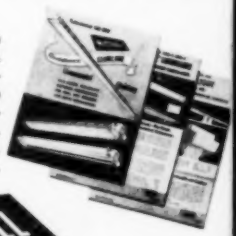
Right across the country, businesses of *every kind* are turning to MITCHELL "Slimline" to get the "selling" light they need. It's uncanny how one installation sells another—in whole communities the commercial lighting swing is to MITCHELL "Slimline".

Progressive businessmen prefer this handsome, smooth, powerful lighting that creates a traffic-building sales-inviting atmosphere. They like the way MITCHELL "Slimline" puts appeal into merchandise, makes it more desirable and easier to sell—the way it produces *measurable* increases in sales and profits.

This user acceptance builds volume business for the wholesaler. MITCHELL "Slimline" installations are easy, smooth jobs for the contractor—time-saving profitable business. And utility men can recommend this superior lighting with confidence.

Whether it's automobiles or lilacs—MITCHELL "Slimline" lights *and sells* them all!

Write for complete descriptive literature covering MITCHELL Slimline fixtures. Ask for Bulletin No. 322 describing 4-Lamp units; Bulletin No. 339 describing 2-Lamp units; Bulletin No. 334 describing spotlight units, for use with Slimline fixtures.



MITCHELL

First Choice in Lighting

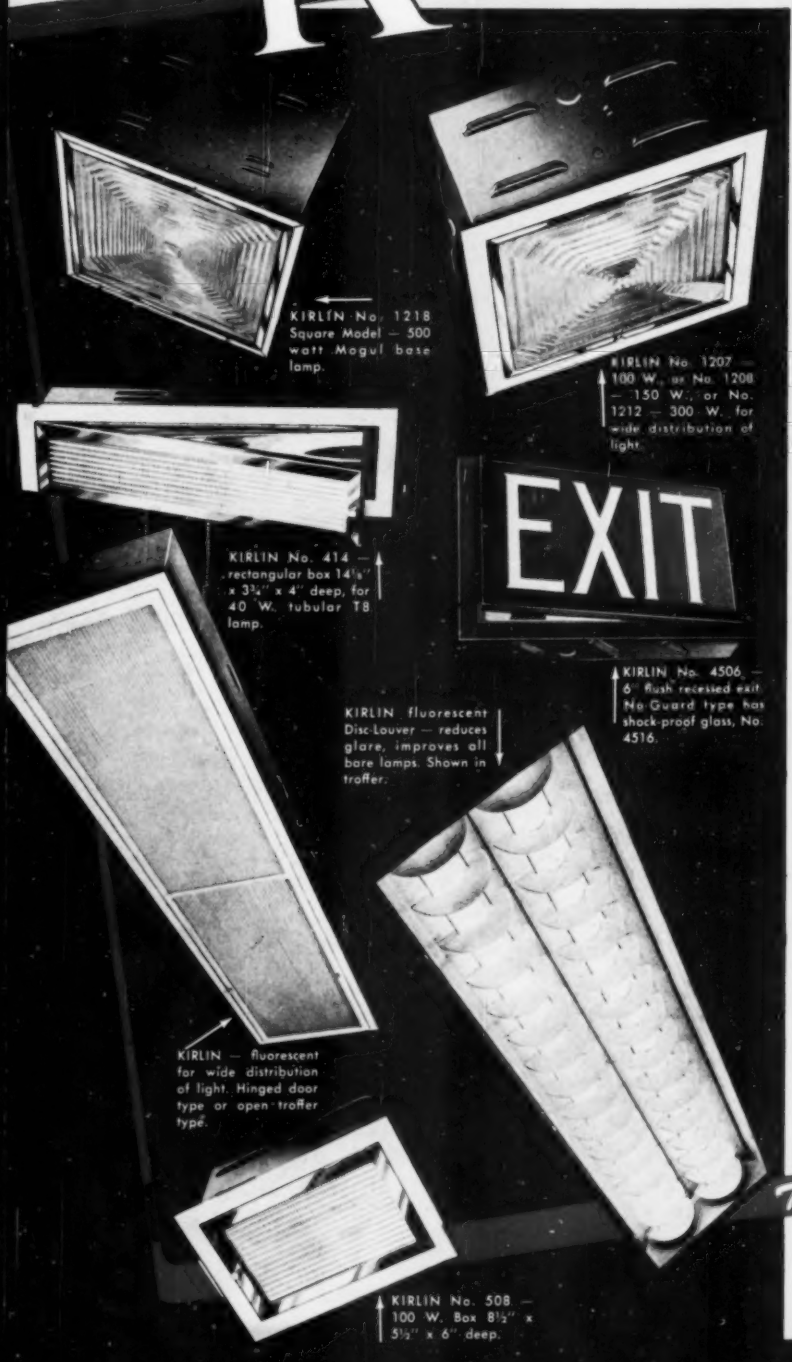
Mitchell Manufacturing Company
2525 Clybourn Avenue • Chicago 18, Illinois
In Canada: Mitchell Manufacturing Company, Ltd., Toronto, Canada

Kirlin

with

ALZAK GLASS SURFACED ALUMINUM REFLECTORS

Hinged Doors
Frames die-cast
Non-ferrous fronts
Neat, nothing hanging
Wide light spread
Unit packing
U. L. and I. B. E. W. labels
Easily installed
Light properly controlled
Easily maintained


KIRLIN No. 1218 Square Model — 500 watt Mogul base lamp.
KIRLIN No. 1207 — 100 W., or No. 1208 — 150 W., or No. 1212 — 300 W. for wide distribution of light.
KIRLIN No. 414 — rectangular box 14⅛" x 3¾" x 4" deep, for 40 W. tubular T8 lamp.
EXIT
KIRLIN No. 4506 — 6" flush recessed exit. No-Guard type has shock-proof glass, No. 4516.
KIRLIN fluorescent Disc-Louver — reduces glare, improves all bare lamps. Shown in troffer.
KIRLIN — fluorescent for wide distribution of light. Hinged door type or open troffer type.
KIRLIN No. 508 — 100 W. Box 8½" x 5½" x 6" deep.

Put the KIRLIN line to work—it will do the finest kind of sales and profit job for you. Here is a recessed lighting line that was designed for modern American homes and business buildings. It gives your customers every benefit in lighting, in appearance, and in long-time economy.

Your immediate good business move would be that of investigation. See why the KIRLIN line is the best buy for your customers — why it is the full and complete answer to today's lighting requirements.

Write for catalog.
Only thru wholesalers.

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3435 EAST JEFFERSON AVE.
Detroit 7, Michigan

KIRLIN COMPANY EQUIPPED THIS COLISEUM

PITTSBURGH PERMAFLECTOR LIGHTING EQUIPMENT.....

"INTERNATIONAL" *Favorite*

GOLD SEAL AWARD to
J. L. Philips, Electrical Engine
for EXCHANGE NATIONAL Ba
Warren, Knight & Davis, Archi

More discriminating users selected Pittsburgh Permaflector Lighting Equipment for their Gold Seal and Merit Awards than that equipment of any other manufacturer.

Over 20% of the Gold Seals awarded at the 3rd International Lighting Exposition for outstanding lighting installations, incorporated Pittsburgh Permaflector Equipment.

This record of achievement is evidence that creatively and practically "Pittsburgh Permaflector" is preferred by men who know lighting best.

If you too want to achieve superior lighting results, our Engineering Department will gladly assist you. Write today.

GOLD SEAL AWARD to
Paul E. Kevs, Duquesne Light Co.
for S. H. LEROY, Jewelers
Hyman Rosenberg, Architect

"Pittsburgh" Permaflector

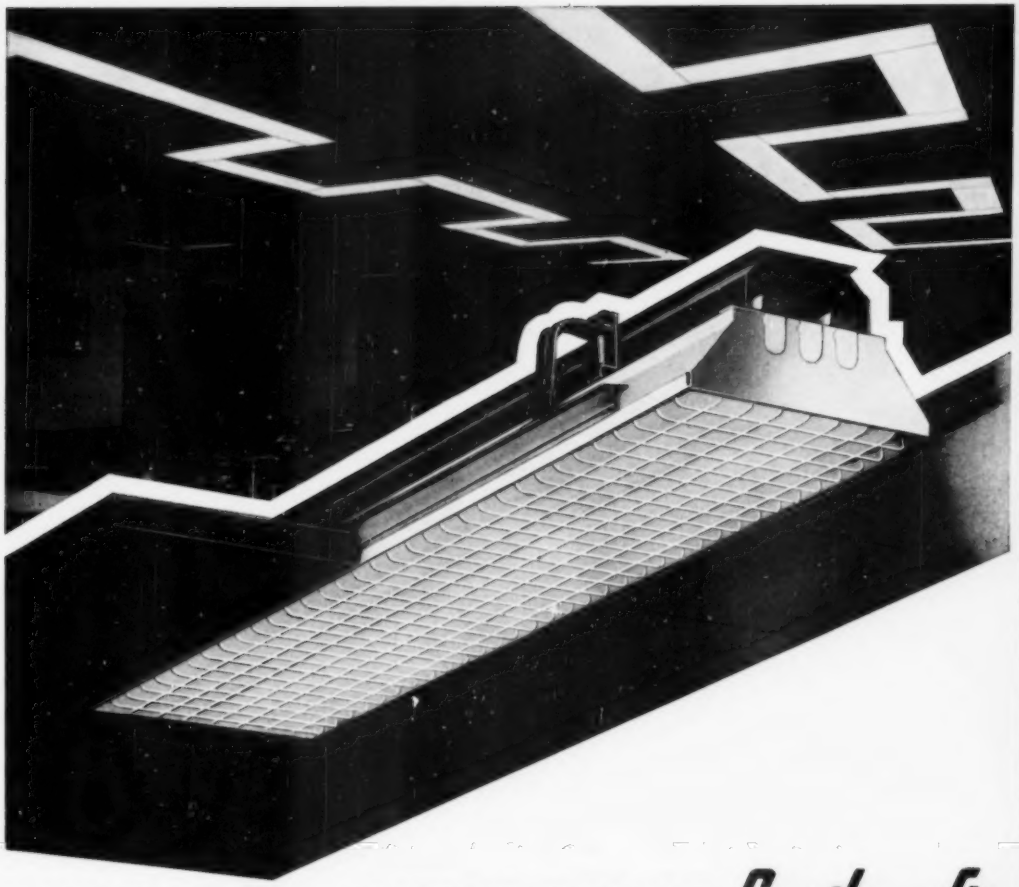
PITTSBURGH REFLECTOR COMPAN

411 OLIVER BUILDING • PITTSBURGH 22, PA.

Permaflector Lighting Engineers in All Principal Cities

PITTSBURGH PERMAFLECTOR LIGHTING EQUIPMENT IS DISTRIBUTED BY BETTER ELECTRICAL WHOLESALERS EVERYWH

PITTSBURGH REFLECTOR EQUIPMENT



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~~**OR EQUAL**~~

there is no equal!

THERE'S A BOOKLET ENTITLED "ARCHITECTURAL TROFFERS" THAT TELLS YOU WHY

write..... ***Smithcraft*** **LIGHTING DIVISION, CHELSEA 50, MASS.**

SMITHCRAFT FIXTURES

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

OV-20 SIMPLIFIES CAR SERVICING AT CINCINNATI UNION TERMINAL

After the day's run, grimy passenger cars are cleaned and serviced faster, more efficiently under OV-20 street lighting units. These flexible luminaires direct the light from high angles to the narrow corridors between the cars. Compared to conventional floodlighting installations OV-20's were found to do a better lighting job and, in addition, prove less costly to install and maintain.

Look to the Westinghouse OV-20 to solve your specialized lighting problems. Either mercury or incandescent sources may be used.

For further information, call your local Westinghouse distributor or write for Booklet B-3876, Box 868, Pittsburgh, Penna.

J-04268

Westinghouse
PLANNED
LIGHTING
PAYS

WESTINGHOUSE FIXTURES IN ADDITION TO [illegible]

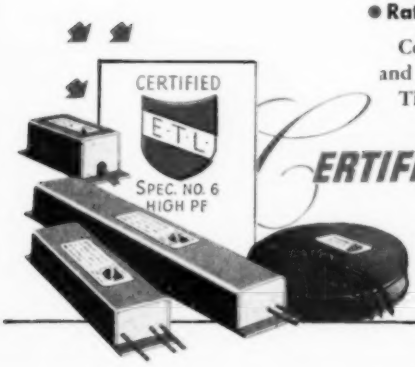
Why I always use CERTIFIED BALLASTS in fixtures I make!

● As a fixture manufacturer, I must have assurance that my complete fixture will be dependable and trouble-free in operation. I can't afford to offer a fixture that doesn't protect wholesalers and contractors and assure greatest satisfaction to the user.

My reputation . . . my business future depend on the performance of the fixtures I make. That's why I always use Certified Ballasts.

Certified Ballasts assure—

- **Full lamp life**
- **Quiet operation**
- **Rated light output**
- **Reliable performance**



Certified Ballasts are made to rigid specifications—then tested and checked by impartial Electrical Testing Laboratories, Inc. That's why I have confidence in Certified Ballasts. You will, too.

CERTIFIED BALLAST MANUFACTURERS

Makers of Certified Ballasts for Fluorescent Lighting

2116 KEITH BLDG., CLEVELAND 15, OHIO

LAMPS

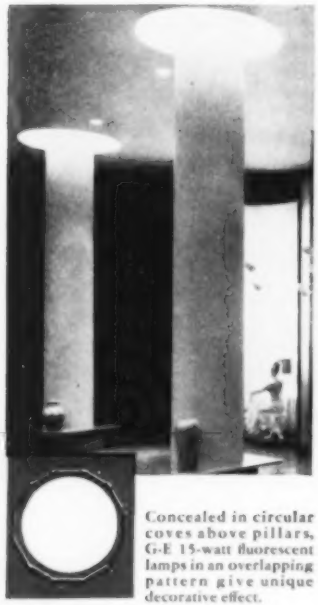
Buyer's Room, Textron, Inc., New York, N. Y.

Bright new design ideas with G-E lamps

Every General Electric lamp in the new buyers' room at Textron, Inc. does double duty—as decorative *and* utility lighting.

For general lighting, General Electric fluorescent and projector lamps add a modern touch, give plenty of light for comfortable seeing. The stage and displays are highlighted by General Electric projector and reflector lamps in distinctive fixtures to focus attention and show off fabrics at their best.

Textron can be sure of getting its money's worth in light from General Electric lamps. Their quality is assured by more than 480 tests and inspections. And they are constantly being improved to STAY BRIGHTER LONGER.



Concealed in circular coves above pillars, G-E 15-watt fluorescent lamps in an overlapping pattern give unique decorative effect.

Display is lighted by G-E 40-watt fluorescent lamps recessed in vertical, tapered post. Three projector lamps on post provide accent lighting on model.

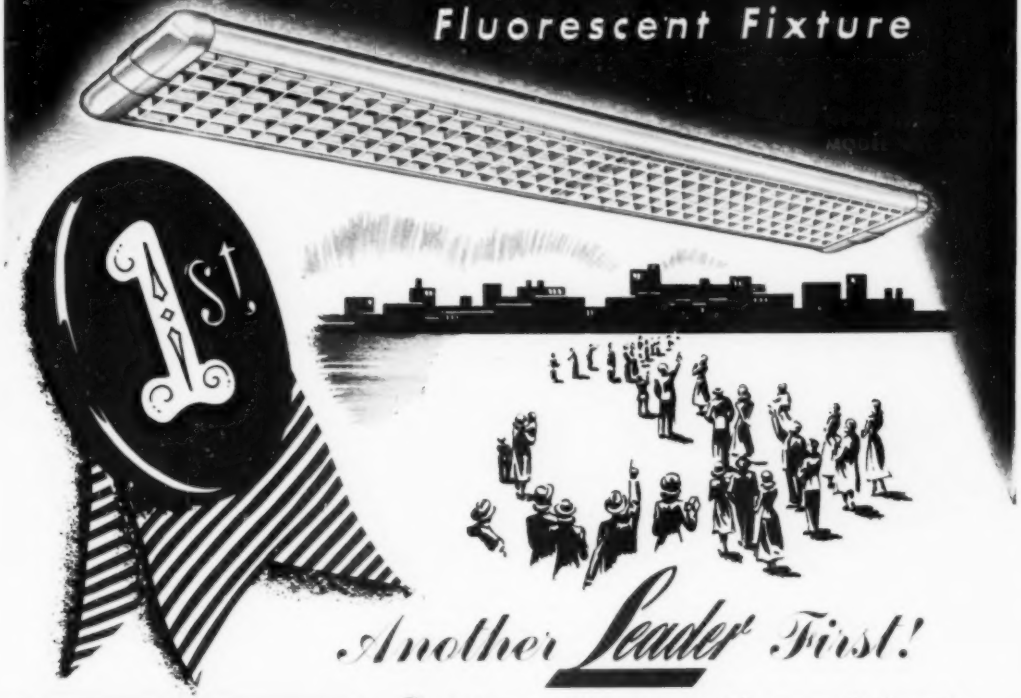
"Floating" fixture has G-E 40-watt fluorescents on top to brighten ceiling. Adjustable projector lamps in bottom bring accent lighting close to display.

Choose the best for your design from the most complete lamp line

GENERAL ELECTRIC

Leader NEW HORIZON

Fluorescent Fixture



1ST

Another Leader First!

. . . and TOPS again!

MERIT AWARD WITH DISTINCTION. I.L.E. LEADER entry 330—H. E. Carney, Toledo-Edison Co., Toledo, Ohio. C. Hoke, Architect (see photo above) . . . Also I.L.E. MERIT AWARDS for LEADER entries 163, 381, 405, 294, 324.

1 **FIRST** successfully-engineered, fully-proven, Slimline-tube lighting fixture.

1 **FIRST** on the drafting board; first into production; first into the testing laboratory; and first on the market!

1 **FIRST** in a beautiful fixture ensemble of gleaming metal and plastic. First to achieve this practical result: Maximum diffusion of horizontally-directed light; muffled glare with a minimum of light interference.

NEW HORIZON, Model NHC-480 (as illustrated above) has drawn aluminum end-caps. Newly-designed, destaticized moulded-PLASTIC lightweight louvers (will not warp or discolor). Fully guaranteed. New-style tubular-PLASTIC translucent side panels . . . Slimline (instant-start) tubes designed for *four* eight-foot tubes; F96-T-8. Also for *two* eight-foot tubes; NHC-280.

Ask for complete mechanical details

LEADER ELECTRIC COMPANY

5600 NORTH KEDZIE AVE. • CHICAGO 18, ILLINOIS

AT KOPP GLASS . . . manufacturing procedure is geared to meet your SPECIALIZED needs

To provide the beam control, color transmission, resistance to service conditions, dimensional accuracy and other characteristics your lenses and roundels must have, KOPP GLASS offers a completely integrated engineering and manufacturing organization. Everything we make is *special*—made to meet a customer's specific needs.

We will be glad to send you a booklet that describes our facilities and shows how we are organized to efficiently serve you.

To assure top quality glass—specify KOPP!

(Top) Checking a lens mould with precisely-cut template, before releasing for production. (Above) Preliminary inspection of a newly pressed lens. (Below) Color and light transmission of regular production are checked with modern laboratory-type equipment.

KOPP GLASS, INC. KOPP GLASS SWISSVALE, PA.

Better Seeing for **Better Selling**

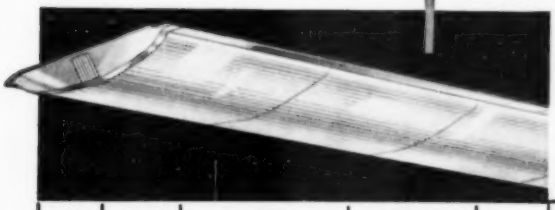
...for Brunwood Motors, Worcester, Mass.

Sleek, graceful lines of these Lincoln cars are emphasized by the longitudinal reflections from Litecontrol fixtures that parallel all display windows. For extra accent, strategically placed lens boxes add sparkle and life to the chrome fittings.

Consulting Engineer: R. E. Lupien . Electrical Contractor: Coghlin Electric Company . Lighting Equipment: Litecontrol No. 9134 recessed lens fixture with 3 lamps and supplementary 250 watt accent lights . Lamps: 40 watt, 3500 degree, white, fluorescent; 250 watt incandescent . Wattage per fixture: 150-fluorescent; 250-incandescent . Total Wattage: 7,600 . Watts per Square Foot: 5.4 . Footcandles: 80 Initially.

Every one of the many Litecontrol fixtures are good to look at — graceful and glare-free. Yet they are capable of putting plenty of lighting punch on working or selling areas. Extra sturdy in construction — easy to install — Litecontrol fixtures are also built for faster cleaning and easier servicing.

Litecontrol engineers are specialists in building sales through better lighting. And they'll be glad to help you with advice — or by furnishing complete lighting layouts. With their technical assistance you can help your customers sell more goods — help yourself sell better lighting to more customers.



...with LITECONTROL FIXTURE NO. 9134

Selected for this automobile showroom was a Litecontrol flush, troffer-type unit using Holophane Controlescent curved lenses. Its optical engineering gives excellent light distribution and reduced contrast between fixture and ceiling. Smooth graceful lines and shallow recess depth blend pleasingly into any modern architectural design.

Cat. No.	No. of Lamps	HOUSING Length	Width	Height	TRIM Length	Width	Weight
9134	2-40W	48"	13⅛"	5⅝"	49⅛"	14⅝"	46 lbs.
9134	3-40W	48"	13⅛"	5⅝"	49⅛"	14⅝"	51 lbs.

End Cap — No. 9100-3. Suspension Strap — No. 9100-6

LITECONTROL CORPORATION
36 PLEASANT STREET, WATERTOWN 72, MASSACHUSETTS

LITECONTROL *Fixtures*
KEEP UPKEEP DOWN

DESIGNERS, ENGINEERS AND MANUFACTURERS OF FLUORESCENT LIGHTING EQUIPMENT DISTRIBUTED ONLY THROUGH ACCREDITED WHOLESALERS

when you're buying fluorescent fixtures

You're on the right track to better lighting when you see this tag on a fluorescent fixture. It means the manufacturer has made use of the industry's finest ballast to assure you of rated lamp life and light output . . . with quiet operation and a minimum of maintenance.

General Electric ballasts are designed, built and tested to get the most out of all standard fluorescent lamps. So for quality and economy in fluorescent lighting, insist on this tag when you're making a purchase—and get the most for your money. *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

FLUORESCENT LAMPS unlike incandescent lamps, do not draw current directly from the lighting circuit. Instead they draw their current through a special transformer or ballast mounted in the fluorescent fixture.

With fluorescent lighting, therefore, the amount of the light you get from the lamp, the life of the lamp, and to some extent the life and efficiency of the fixture itself, depend in large measure on the characteristics of the ballast. Good ballasts mean better lighting.

GENERAL ELECTRIC

412-72

(Continued from page 373)

TEXTILE LIGHTING

Figure 17. The finished cloth is inspected on perch boards. Supplementary lighting units containing ten 40-watt daylight fluorescent lamps in specular reflectors provide the 300 to 400 footcandles required for this seeing task.

pared under similar working conditions since such tests require considerable time. Obviously, unless exactly the same materials and operations are involved, direct comparison of lighting systems cannot be made.

(b) During the period from 1941 to 1948 occasional tests of this nature were conducted in the mills of a large textile organization. In each test all labor, machines, materials, and processes were unchanged; the lighting was the only variable. The data presented in Table II show the effect of various lighting installations on production efficiency and spoilage for spinning and weaving.

6. References

1. "Report on Lighting in the Textile Industry — Grey Goods and Denim," *Transactions I.E.S.*, Vol. XXXII, No. 3, p. 247 (March, 1937).
2. "Lighting for Silk and Rayon Throwing and Wide Goods Weaving," *Transactions I.E.S.*, Vol. XXXIII, No. 1, p. 17 (January, 1938).
3. Holdsworth, T. C., Howell, J. W., and Jackson, J. H., "Lighting in the Woolen and Worsted Industry," *Transactions I.E.S.* (London), Vol. VII, No. 8 (September, 1942).
4. Duncan, A. F., "Lighting in the Textile Industry," *Building and Engineering* (Australia), p. 33 (October 24, 1944).

NEW MEMBERS

(Continued from page 386)

Associate Members:

Evans, Robert A., General Electric Supply Corp., Seattle, Wash.
Honey, M. J., Seattle Lighting Fixture Co., Seattle, Wash.
Penning, J. R., Smitheraft Lighting Division, Seattle, Wash.
Theisner, William G., Fluorescent Fixtures of California, Seattle, Wash.

ROCHESTER CHAPTER

Associate Member:

Shaprow, Harry H., Royalite Electric Supply Corp., Rochester, N. Y.

ROCKY MOUNTAIN CHAPTER

Associate Members:

Janza, Frank J., Denver University, Denver, Colo.
Watters, William L., Denver Public Schools, 414 14th St., Denver, Colo.

SOUTHERN CALIFORNIA SECTION

Member:

Call, Earle C., Ralph M. Parsons Co., Los Angeles, Calif.

Associate Members:

Phillips, Eugene, Lighting, Inc., Los Angeles, Calif.
Phillips, James E., Jimmy Phillips Sales Agency, Los Angeles, Calif.

(Continued on page 23A)

ACCENTUATE THE POSITIVE
USE ORIGINAL SOLID CORRUGATED GLASS

To see or not to see is a question of paramount importance. Be positive about seeing anywhere in your office or shop by using Corrugated Glass to get good light and plenty of it.

Manufactured by

Pennsylvania Wire Glass Company
1612 MARKET STREET PHILA. 3, PA.

Are YOU
Up to the minute in Lighting Practice?
I. E. S. LIGHTING DATA SHEETS
SERIES XIV
are the last word in lighting applications!

Subscriptions are now being taken for the complete Series XIV, 24 sheets in all; the first seven ready for immediate mailing. Subscription $1.25 singly—special binder $1.50. Order now direct or use easy-ordering form from May issue.

ILLUMINATING ENGINEERING SOCIETY
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(See future issues for complete list of I.E.S. publications)

MULTI

A WORD WHICH MEANS MANY,

AND MANY ARE THE ADVANTAGES WHEN MULTI INDUSTRIAL LIGHTING FIXTURES ARE SPECIFIED.

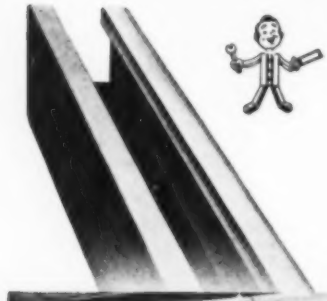
RLM REFLECTORS
VAPOR PROOFS
FLOODLIGHTS
FLUORESCENTS
GYMNASIUM FIXTURES

YOU CAN DEPEND ON MULTI FOR
- QUALITY OF MATERIAL AND WORKMANSHIP
- PRACTICALLY ENGINEERED DESIGNS
- A SIZE AND TYPE OF FIXTURE TO MEET THE REQUIREMENTS OF ALL INSTALLATIONS

• DISTRIBUTED THROUGH LEADING WHOLESALERS •

MULTI ELECTRICAL MFG. CO.
4223-43 WEST LAKE ST. CHICAGO 24

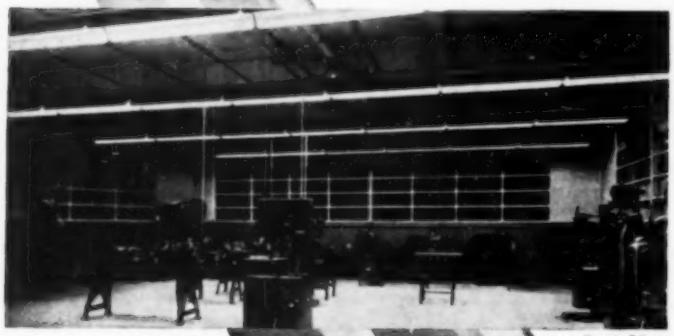
Hang fluorescent fixtures the UNISTRUT way



True Fixture Alignment – the Unistrut Channel is perfectly rigid and straight – doesn't warp, bend, or get out of line.

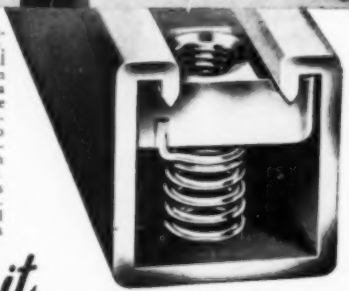
Fewer Hanger Rods with Unistrut – they can be spaced much farther apart than by any other method, resulting in better appearance and lower costs.

Complete Flexibility – hangers may be installed at *any* point along Unistrut continuous slot channel.



Detroit Edison Photo

Above: Typical Unistrut installation supporting heavy, double 100-watt industrial type fluorescent fixtures. In this case Unistrut serves a dual purpose. It forms the rigid channel to which fixtures are attached, and is also installed in the ceiling to suspend the hanger rods which support the fixture assembly. Note also that Unistrut has been used in the above machine shop to build tables and benches, and to support tools and motors.



they did it with UNISTRUT

You too can utilize Unistrut's "Strength without Bulk" for your fluorescent fixture installations. Unistrut can also be used to build supports for cable, conduit, pipe and electrical equipment of all kinds—all types of shelving, framing, mounts, racks, tables and benches—and many other structures, with only a hacksaw and a wrench.

Completely adjustable and reusable, Unistrut is steel channel with a continuous slot. You simply insert the Unistrut spring nut at the approximate point where attachment of another framing member is desired, slide to exact position and bolt to Unistrut fitting. No drilling or welding required.

Write for Bulletin

U. S. Patent Numbers
2327587 2329815 2345650
2363382 2380379 2405631
Representatives in Principal Cities

ALL PURPOSE UNISTRUT METAL FRAMING

THE 3 QUICK UNISTRUT STEPS

Insert Nut into Channel | Locate Fitting and Nut | Tighten Bolt – that's all

UNISTRUT PRODUCTS COMPANY
1013 W. WASHINGTON BLVD., CHICAGO 7, ILL.

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(*Continued from page 21A*)

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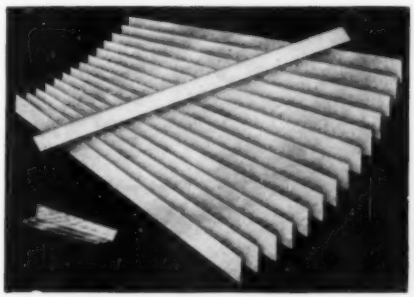

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X	X	X		Appleton Electric Company						
X	X	X	X	Benjamin Electric Mfg. Co.	X	X	X	X	X	X
X				Bright Light Reflector Co.	X	X		X	X	X
				Day Brite Lighting, Inc.	X	X		X	X	X
X				Jones Metal Products Co. (Aboilite)						
X				The Miller Company	X	X	X	X	X	X
				Mitchell Manufacturing Co.	X	X		X	X	X
X	X	X	X	Multi Electrical Mfg. Co.						
X		X		Overbagh & Ayres Mfg. Co.						
X	X	X	X	Quadrangle Mfg. Company						
X	X	X	X	Smoot-Holman Company	X	X		X	X	X
				Sylvania Elec. Products, Inc.				X		X
X	X	X	X	Westinghouse Electric Corp.	X	X	X	X	X	X
X	X	X	X	Wheeler Reflector Company	X	X	X	X	X	X

* Based upon latest information furnished by members.

** *Spec. #22 covers a new 2-40 W fluorescent longitudinal shield unit.*

R-3351

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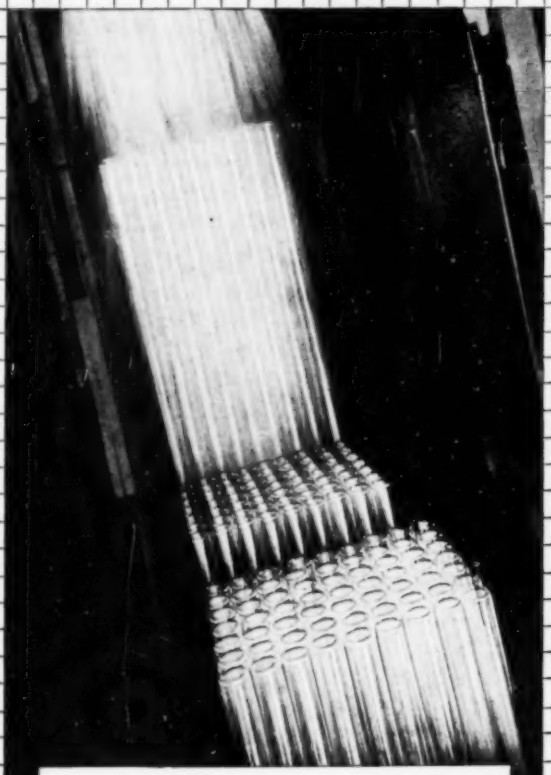

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